



AFC Energy

AFC Energy plc  
Annual General Meeting Presentation

24 April 2018

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# Hydrogen Council Vision for 2050

According to the Hydrogen Council, by 2050, the H<sub>2</sub> economy is expected to:

Meet  
**18%**  
of the  
World's Energy Demands

Support Avoidance of  
**6 Gt.**  
of CO<sub>2</sub> Emissions

Global Revenues of  
**US\$2.5 trillion**  
annually

**30 million**  
jobs created across value  
chain

**To be a leader in this sector must be seen as a prize worth pursuing**

**“To become the leading provider of clean energy solutions across the hydrogen value chain in order to deliver long term value to shareholders with minimal environmental impact”**



# How We Will Achieve Our Vision

<b>Deep Technology Development</b>	
<b>Being Production Ready</b>	
<b>Having a Focused Business Model</b>	
<b>Global Applicability</b>	



# Deep Technology Development

# Deep Technology Development



At the heart of AFC Energy's commercial success is its' leading hydrogen fuel cell technology platform. Over the past 12 months, we have successfully delivered:

- > A high powered fuel cell we believe is capable of delivering on the P.L.A.C.E metrics of commercialisation
- > An optimised, validated FC stack architecture that addresses the majority of failure modes evidenced over recent years
- > Evidenced electrode life in excess of 2 years with a clear roadmap towards 4 years in collaboration with De Nora
- > Reduced power leakage from within the fuel cell stack by >80 %
- > Reduced nickel content of the electrode by 88% - materially reducing system cost
- > Removed the need for over 1km of gasket and sealing per stack which previously created gas and liquid leak paths
- > Reduced catalyst content of electrodes by a factor of 4 (vis a vis 2016)
- > A simulation based engineering and modelling of stack and system performance accelerating system development
- > Evidence of cycling (on-off-on) of electrodes not previously seen at AFC Energy
- > Continued to utilise lower industrial grade hydrogen in all testing and industrial demonstrations

The achievements made throughout the course of 2017 and continue to be made into 2018 now provide a basis upon which we have an evidence based forecast target power price, excluding hydrogen, of:

**<US\$0.10 / kWh**

## Deep Technology Development (cont.)

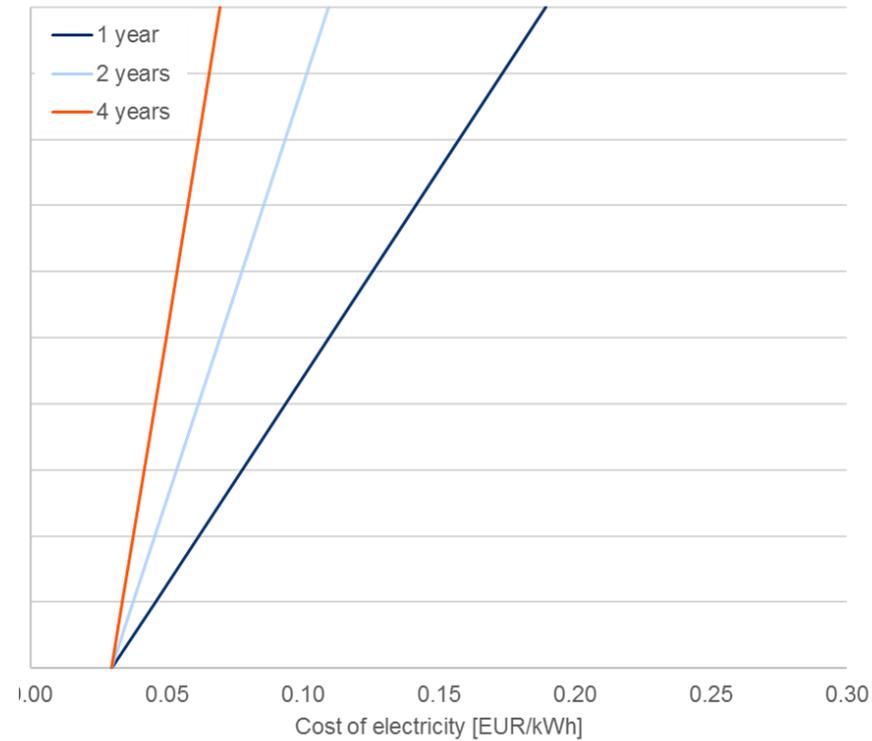
Focus of core technology development across 2017 included:

- (i) Improvement of electrode longevity and reduction of failure modes within the fuel cell stack, and
- (ii) Material reduction of fuel cell cost and mass production readiness



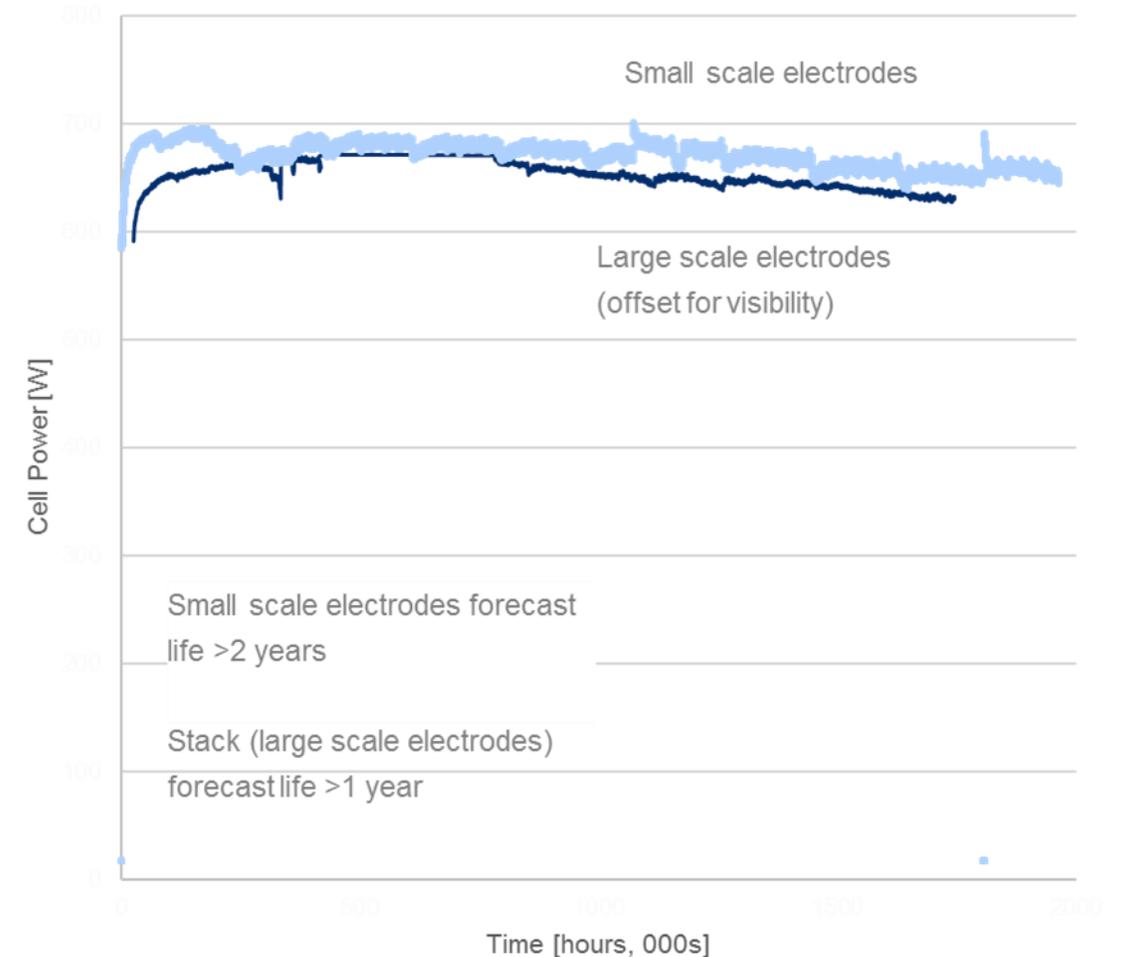
## Longevity

The importance of electrode and stack longevity to the economics of the fuel cell system (1yr, 2yr, 4yr life)



## Longevity (cont.)

- > In 2016, AFC Energy's target was to deliver an electrode capable of operation for >1,000 hours.
- > In 2017, AFC Energy achieved electrode longevity (extrapolated), in collaboration with De Nora, > 2 years on small scale systems
- > At full scale, extrapolated life of electrodes is well over 1 year and improving each month – longest running full scale electrode stack is operating as we speak and has been for several months – our best performing electrodes to date
- > De Nora and AFC Energy are currently working to make further inroads into the newly stated aspiration of 4 year electrode life not dissimilar to electrode life achieved by De Nora in other industries and sectors



## Longevity (cont.)

2017 also saw a redesign of the fuel cell architecture and distribution plates to mitigate a number of failure modes that stemmed from system leakage and sub-optimal flow and distribution of gas and liquid

Images removed  
for sensitivity

Improvements in the latest design of plates include:

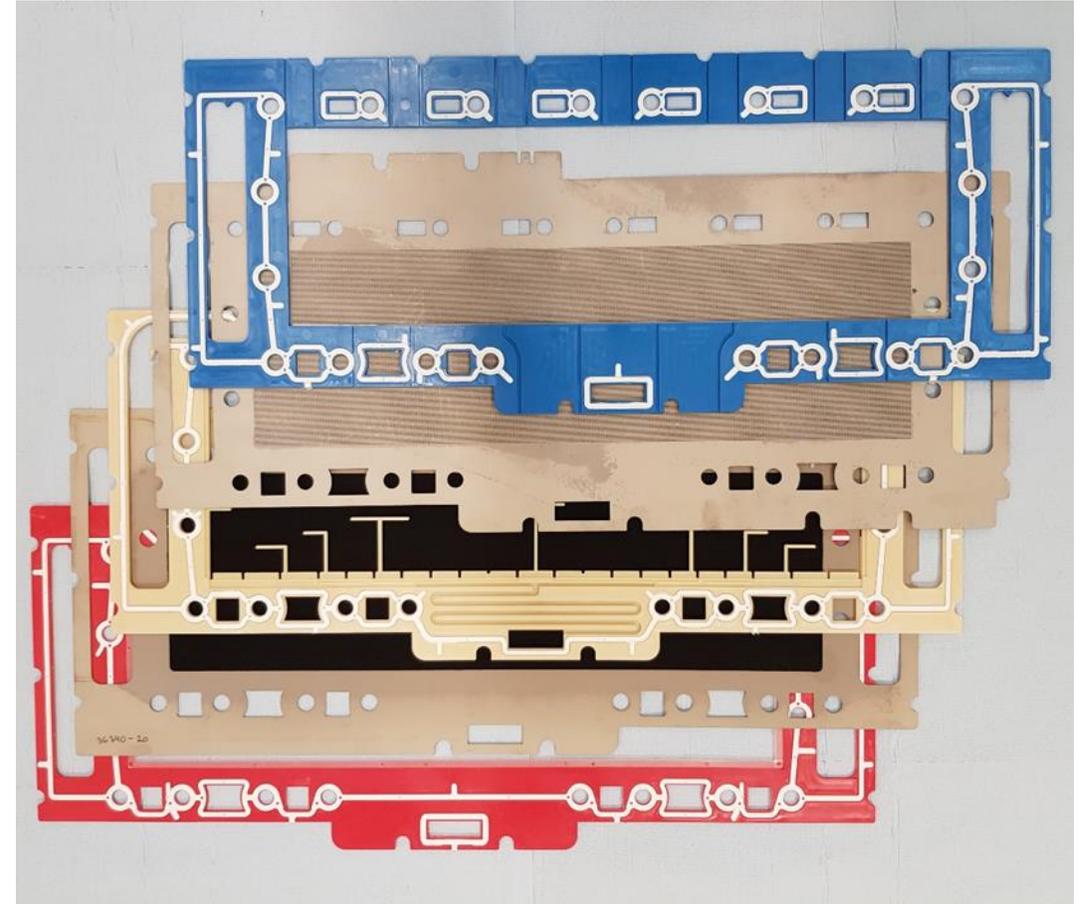
- Lower amount of surrounding components, limiting the risk of fluid leaks
- Simpler access ports, improving distribution across the stack assembly
- Collector at the bottom of the plate reduces risk of liquid flooding
- Less tortuous geometry better directs the flow inside the plates, reducing poorly fed areas. Flow is more stable and less violent

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for sensitivity

## Deep Technology Development (cont.)

Previous GEN2 cell technology utilised large nickel sheets with the electrochemistry bonded to the surface. Multiple components are shown that are assembled into an alkaline fuel cell.

- ▶ 6 interfaces per cell
- ▶ High cost (Ni content)
- ▶ Higher parasitic loss
- ▶ Inefficient flow of gas and liquid
- ▶ Approximately 1km linear seal per stack (high risk of leakage)
- ▶ Exposed IP (design visible)

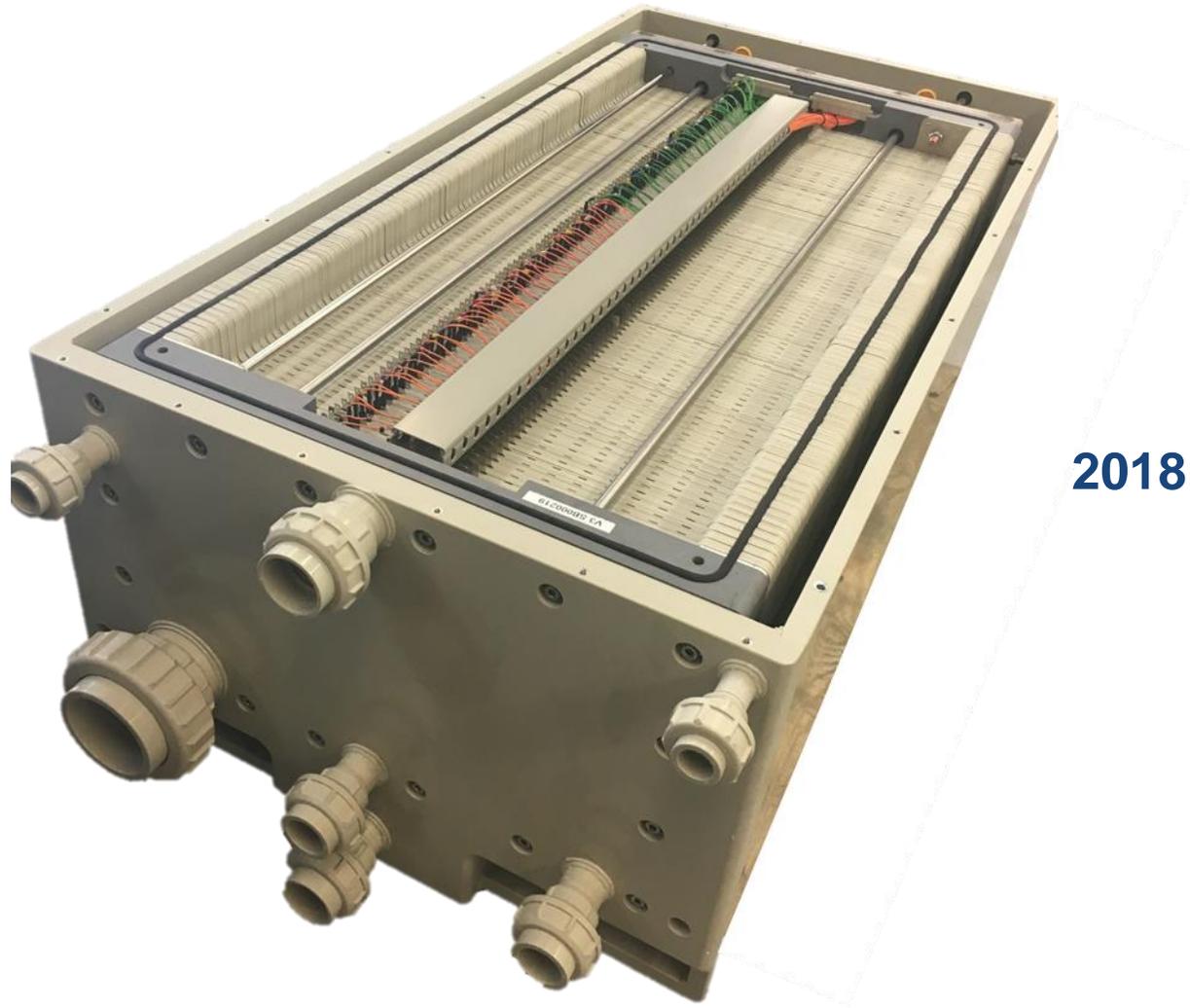


## Deep Technology Development (cont.)

Latest generation cell technology mitigates a number of failure modes and complexities of the previous stack, and, now fully modelled at 100 cell stack configuration, is AFC Energy's new commercial basis of engineering and design.

- 2 interfaces per cell
- 88% reduction in nickel content
- Factor of 4 reduction in catalyst
- Substantial reduction in leak opportunity
- Reduced parasitic loss within stack
- Designed for mass manufacture
- IP internalised within cell architecture
- Currently in operation at AFC Energy Stade facility



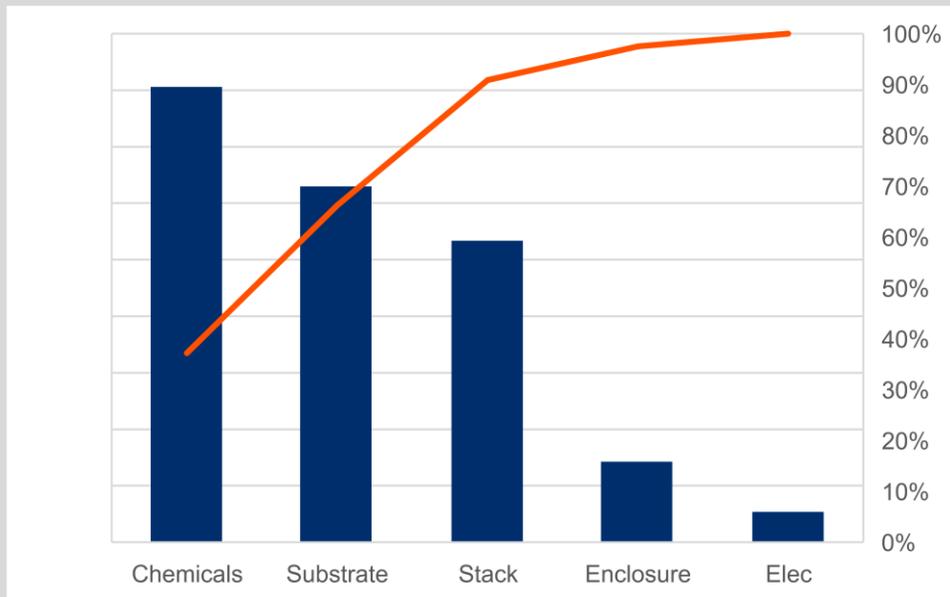


**2018 Fuel Cell Stack Design**

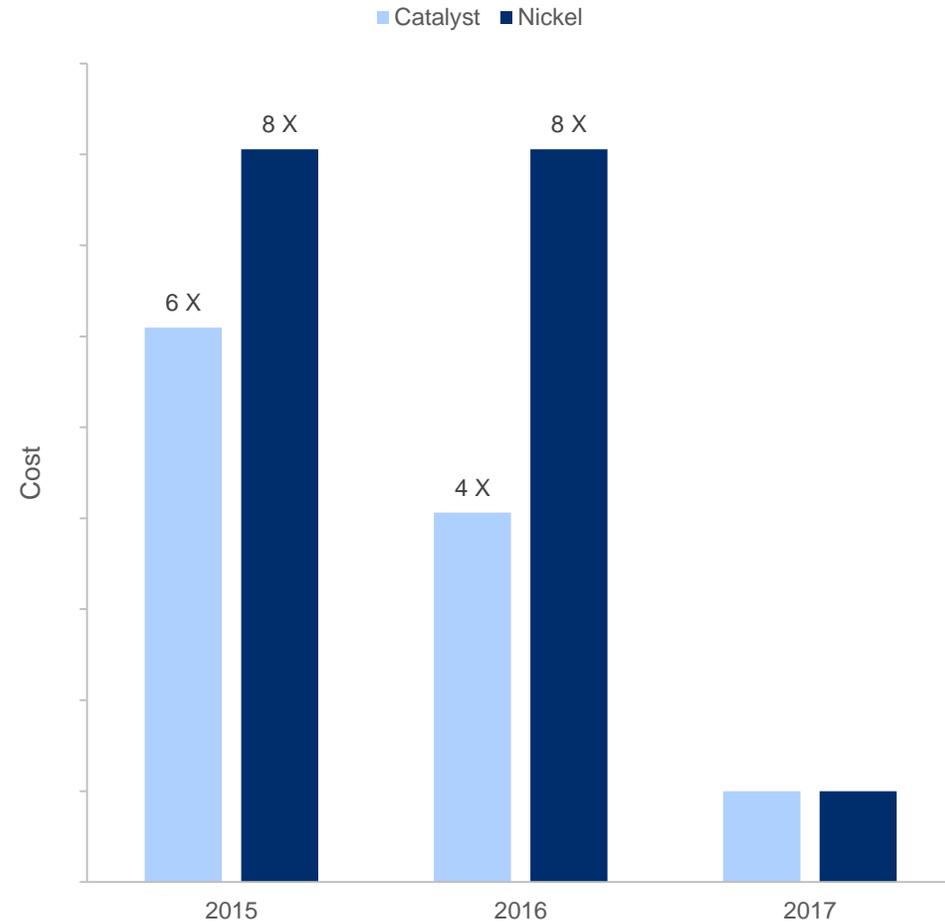
## Cost Reduction

The 2 major costs in the GEN1 cartridge were:

- Fuel cell electro-catalyst (chemicals)
- Nickel electrode substrate



Electrode Cost Reduction - 2015 to 2017



\*Assuming fixed base metal cost



# Being Production Ready

## Electrode

- AFC Energy continues to make real progress with De Nora in the development of a robust and commercial fuel cell electrode
- Increasingly exciting and cost reducing electrode developments which will be assessed under the De Nora JDA throughout 2018
- Principles of the Mass Manufacturing Agreement continue to advance
- AFC Energy now working closely with De Nora's German based manufacturing team in preparation for mass manufacture of electrodes for commercial project development
- Progress throughout '17 and '18 continues to position AFC Energy for delivery of electrodes of quality and in due course, warranted in performance, for large scale commercial deployment



### Fuel Cell Stack and Balance of Plant

- ▶ New fuel cell design with fewer component parts and reduced interfaces - primary driver towards mass production and simplicity of assembly
- ▶ Supply chain capable of mass production of stack components and parts across Europe and Asia being assessed
- ▶ Detailed principles of stack engineering and design now complete allowing for greater clarity of supply chain needs, capability and costings
- ▶ While commercial basis of design now confirmed, further cost reduction opportunities continue to be assessed
- ▶ 2018 will drive and confirm AFC Energy as production ready for scalable deployment





# Focused Business Model

# Focused Business Model

- AFC Energy has long regarded the chlor alkali sector, and other large scale hydrogen emitting industries, as a cornerstone of its addressable market.
- Following meetings in the U.S. at the De Nora client conference in 2017, this market and the opportunity for scalable deployment remains as true today as ever.
- The key driver for focusing on this market was the readily available supply of hydrogen – however, the challenge for AFC Energy is the often very low price of power paid by industrials through Government subsidies or direct deals with the power companies due to the high volume of power consumed.
- This does not change the scope and focus AFC Energy has on this market, but it does emphasise the need to continue to drive costs ever lower.
- In response, AFC Energy is engaging with new and incremental markets where it believes:
  - capital costs are lower
  - barriers to entry are lower
  - power prices (and therefore margins) are higher, and
  - the market size has the potential to dwarf that of the chlor alkali market
- The key here though is identifying access to new, low cost and readily available hydrogen – and lots of it.



## Focused Business Model (cont.)

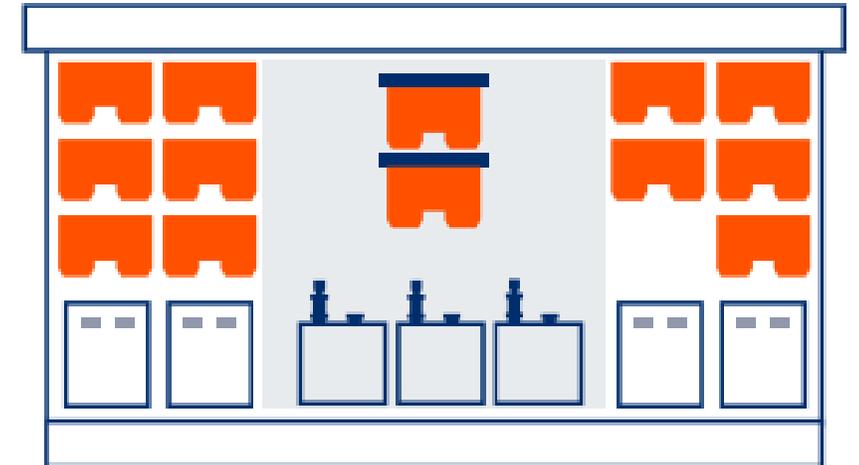


- The opportunity, for example, to displace diesel in the energy mix represents a > US\$20 billion per annum market
- The key is not so much the fuel cell technology, but identification of new and affordable hydrogen sources that allow “on site” hydrogen / power generation.
- AFC Energy is collaborating with several international cutting edge technologies to license H2 generation methods for integration with the AFC Energy fuel cell.
- **Offering a single, clean, base load or intermittent power solution to end users through onsite hydrogen generation and conversion (through fuel cells) ... without the need for additional energy storage ... is very appealing.**
- At AFC Energy, through utilisation of our existing fuel cell technology platform (NOT SEPARATE AND NEW FUEL CELL TECHNOLOGIES) we are now clearly and demonstrably focussed on a three market strategy:
  - Base Load Power Generation
  - Off grid and Remote Diesel Displacement
  - Hydrogen Battery
- We are extremely excited about the new and emerging opportunities arising from these three key markets and expect to make commercial announcements on each throughout the course of 2018

## Next Twelve Months

The next twelve months has a number of exciting advances and announcements that will solidify and validate the technical progression we've achieved over the past three years:

- Confirmation of third party licensors for the integration of state of the art hydrogen generation and downstream AFC Energy fuel cell system integration opportunities across the Company's three focus markets
- Deliver "first of a kind" demonstrations of the integrated AFC Energy fuel cell with third party hydrogen generation technologies
- Complete the requisite steps and agreements to enable mass manufacture of the fuel cell system, including the key electrode manufacturing agreement
- Development of electrodes with durability of 4 years to confirm the target price of power generation (excl. fuel)
- Value engineering of stack and cartridge components with mass production supply chain partners
- Advance commercial dialogue with existing and new hydrogen emitters (through technology demonstrations and updates) with the expectation of an agreement during the course of 2018





Thank you for your kind attention – we are now open for questions.

[www.afcenergy.com](http://www.afcenergy.com)

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