

Cost reduction of water electrolyzers via insights into anode current collector corrosion

Dr Gareth Hinds FREng
NPL Fellow & Science Area Leader
Electrochemistry Group

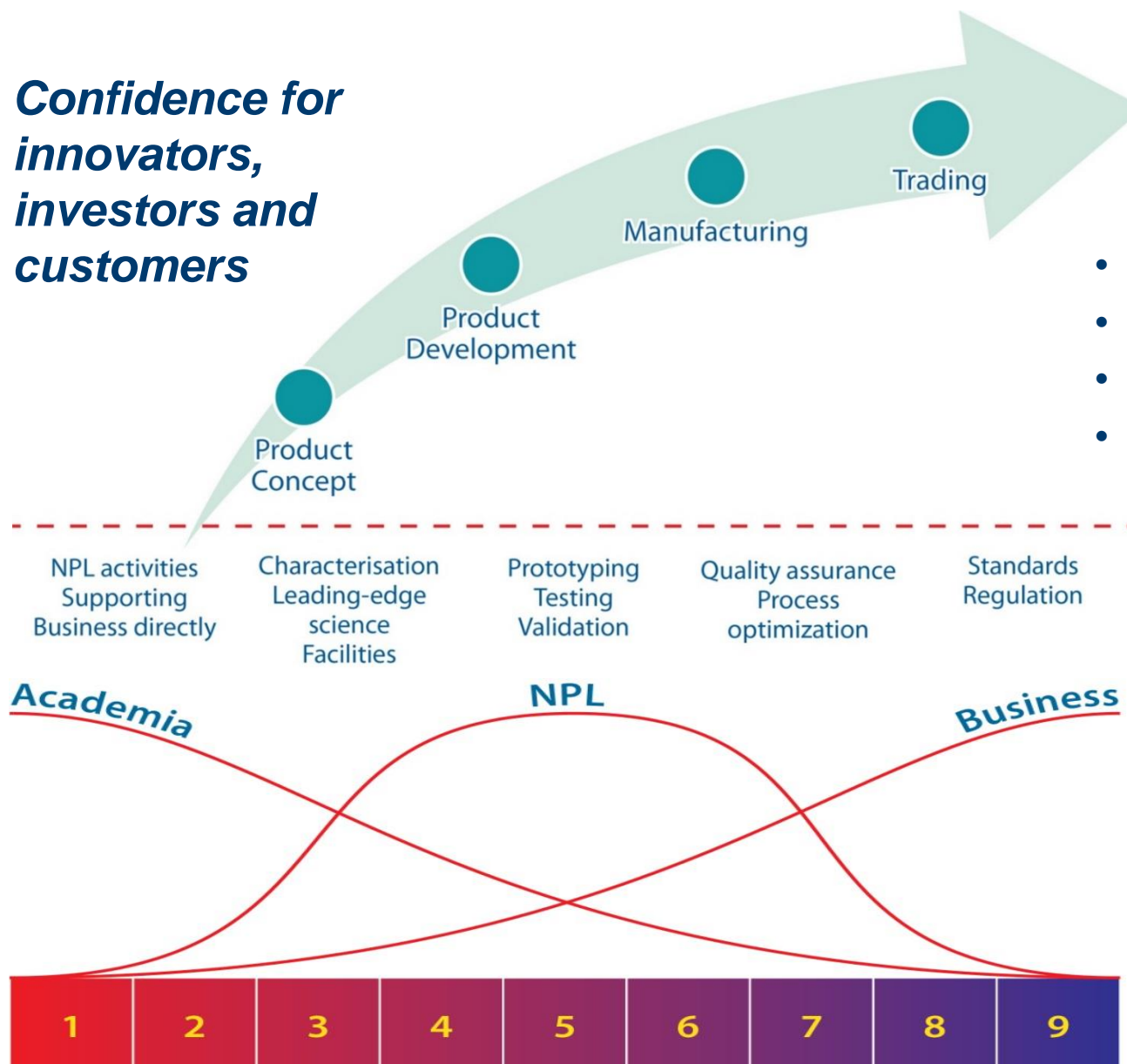




- UK's national standards laboratory
- Founded in 1900
- 1000 scientists/engineers
- Research and consultancy focused on measurement, testing and standards

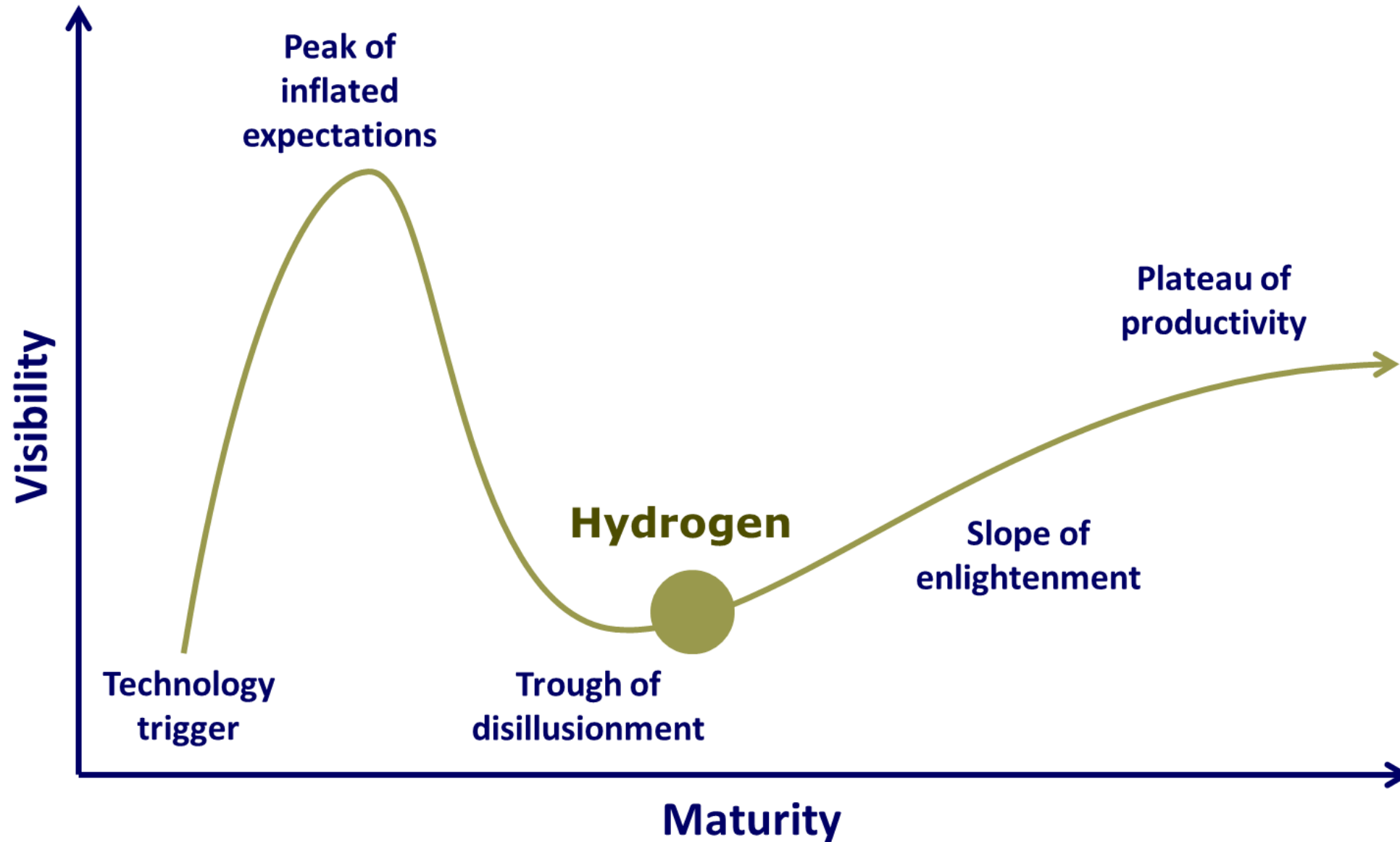
Role of measurement

***Confidence for
innovators,
investors and
customers***



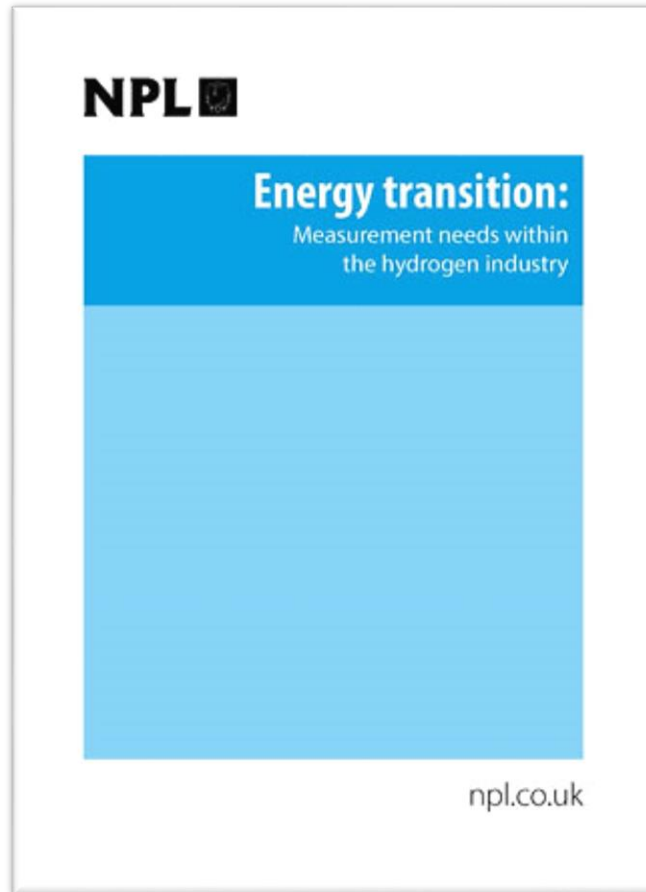
- Validating performance
- Providing confidence
- Driving productivity
- Underpinning standards

Hydrogen – not a hype cycle this time round?





Measurement needs for the hydrogen industry



Material development for fuel cells and electrolyzers

Impact assessment of added **odorant** to hydrogen to aid leak detection

Determination of the **blend ratio** when hydrogen is mixed with natural gas in the gas grid

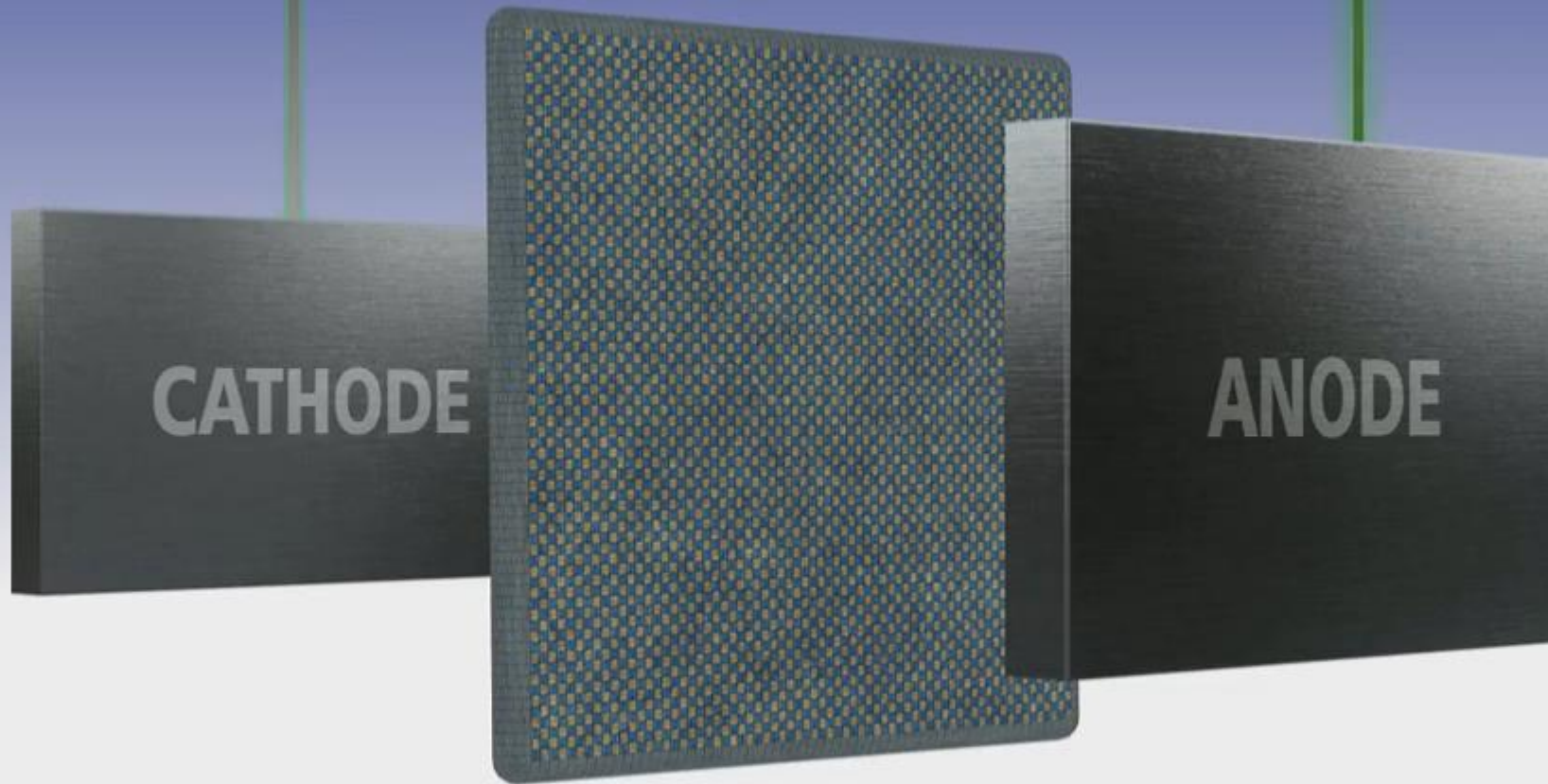
Measurement of the **combustion properties** of hydrogen

Assessment of the suitability of **existing gas infrastructure and materials** for hydrogen transportation

Validated techniques for **hydrogen storage**

<https://www.npl.co.uk/resources/energy-transition/hydrogen-industry>

How an electrolyser works



PEM water electrolyser stack cost breakdown

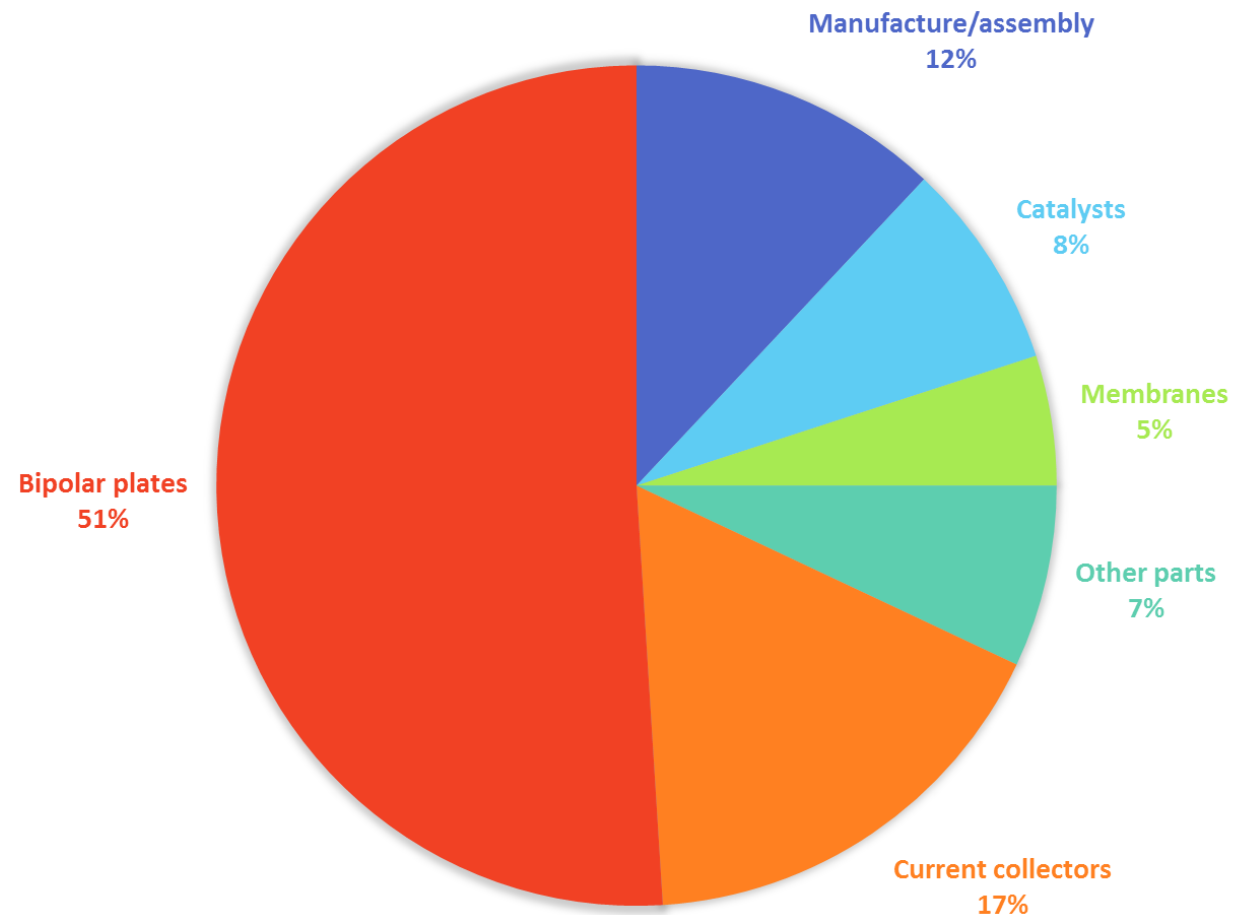


Today's cost

€1,400/kW

EU target (2030)

€500/kW



Source: E4Tech and Element Energy (2014)

PEM water electrolyser stack cost breakdown

Today's cost
€1,400/kW

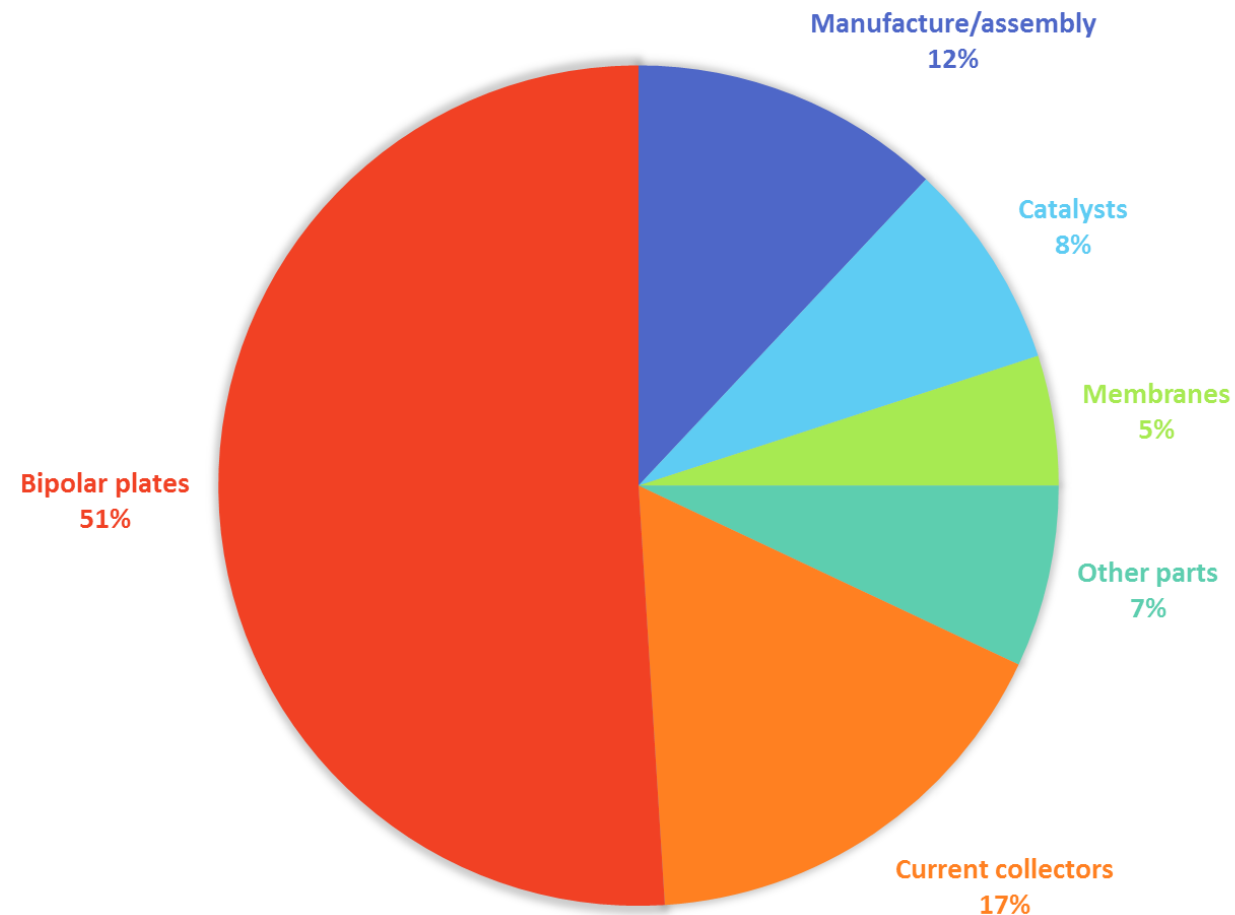
Bipolar plates and current collectors are typically made from platinum-coated titanium, which is expensive to source and manufacture



WHY?

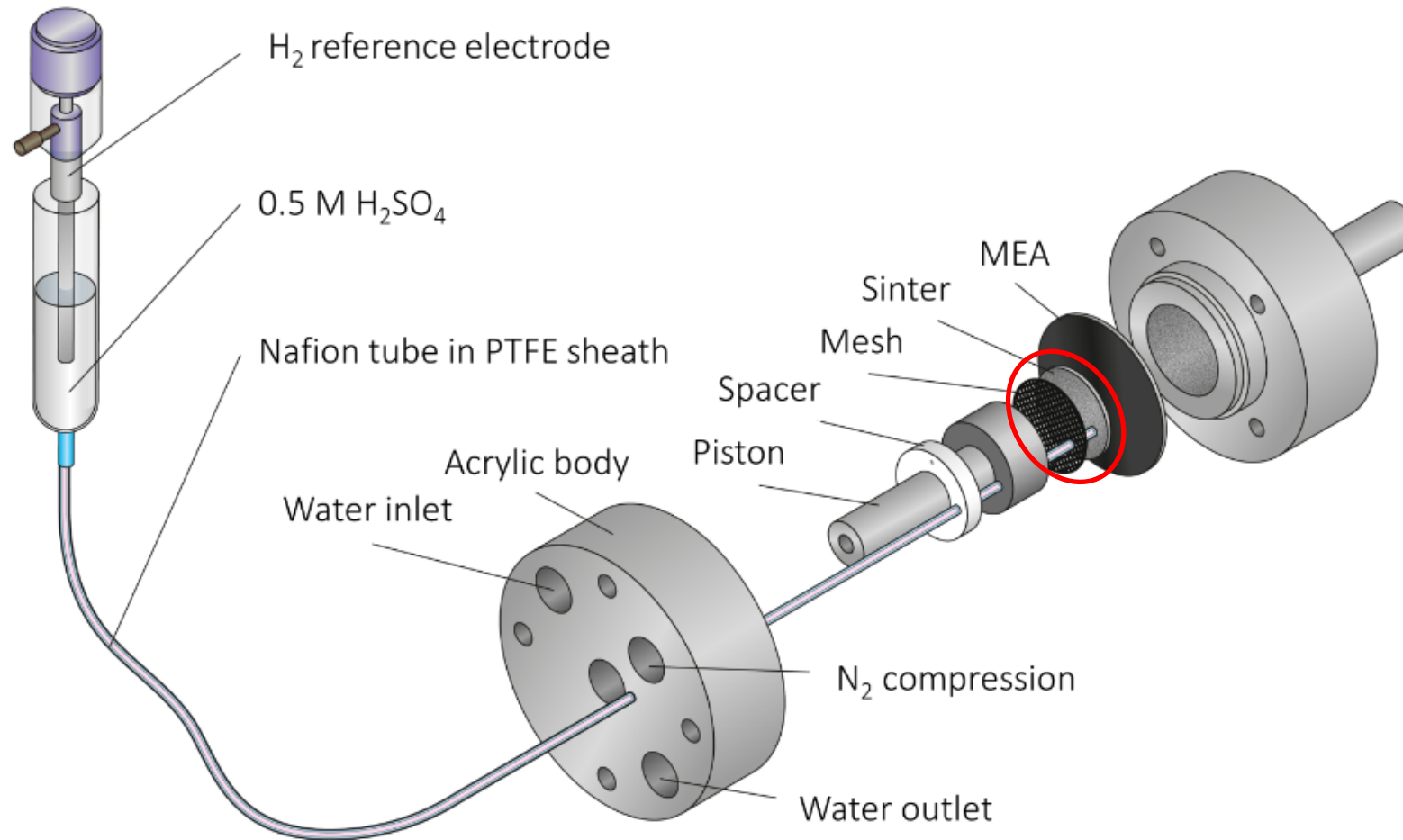
Perceived need for corrosion resistance at high potentials (~ 2 V)

Particularly at anode (oxygen) electrode

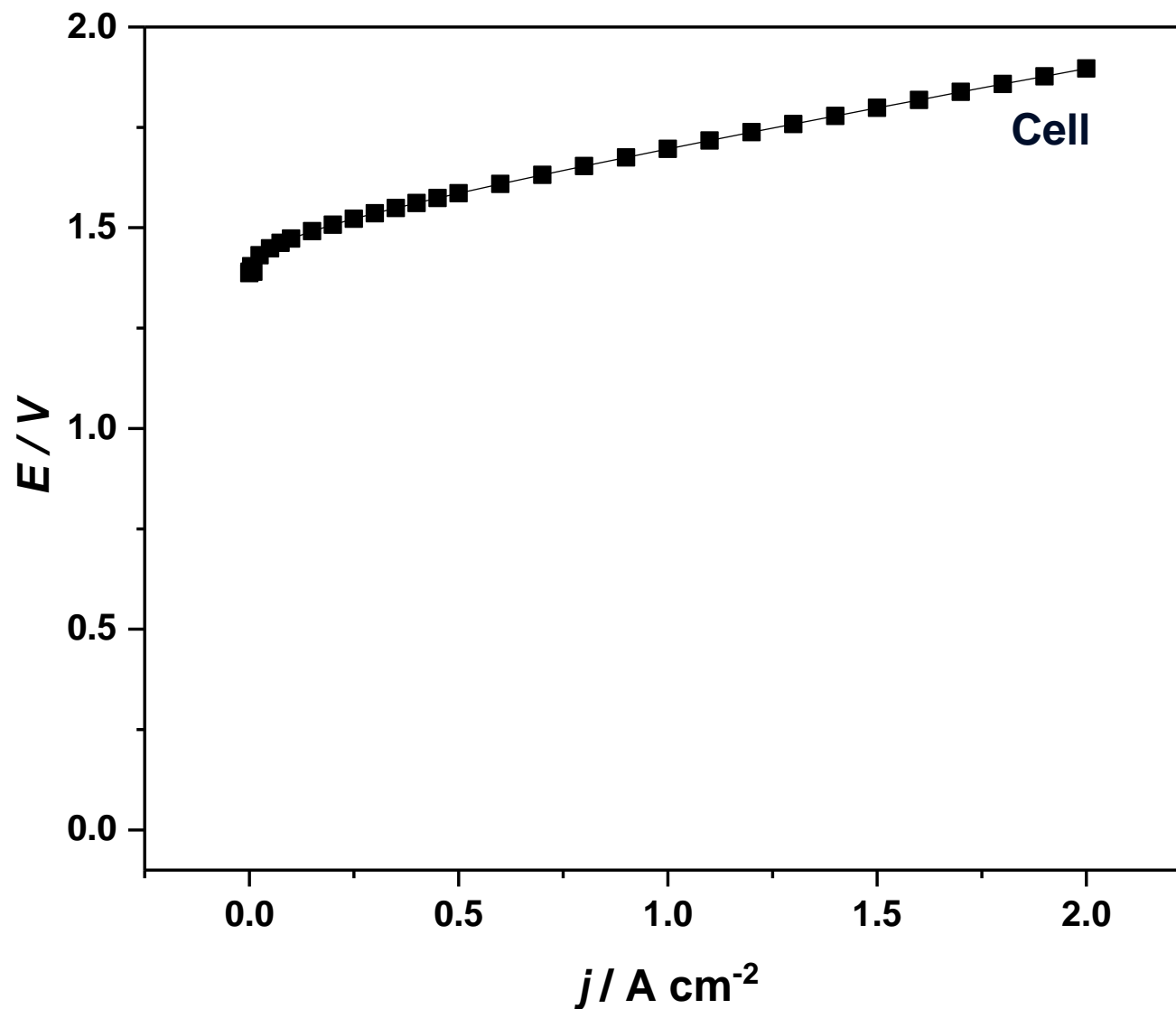


Source: E4Tech and Element Energy (2014)

What is the corrosion potential of the current collector?

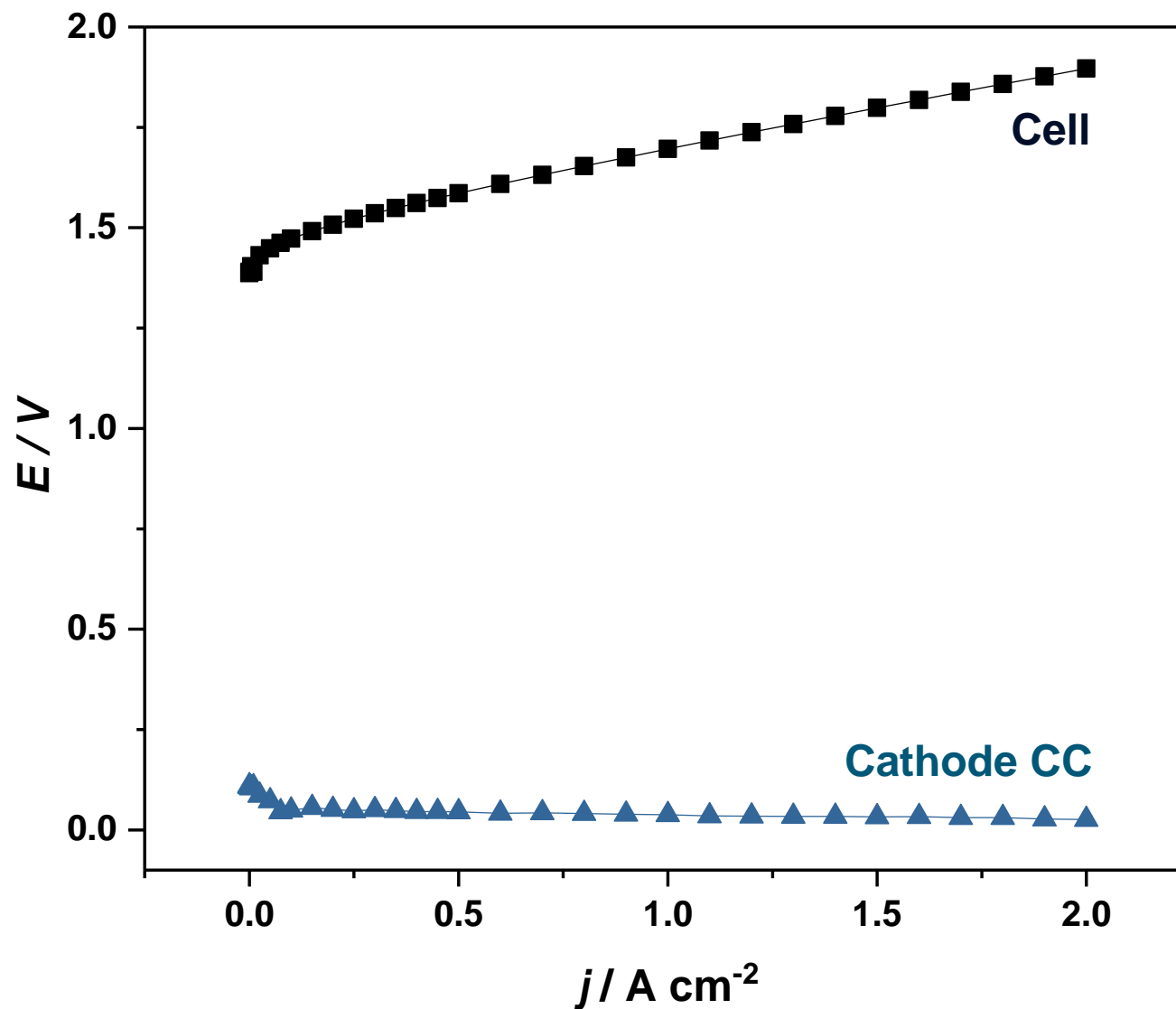


In situ reference electrode measurements



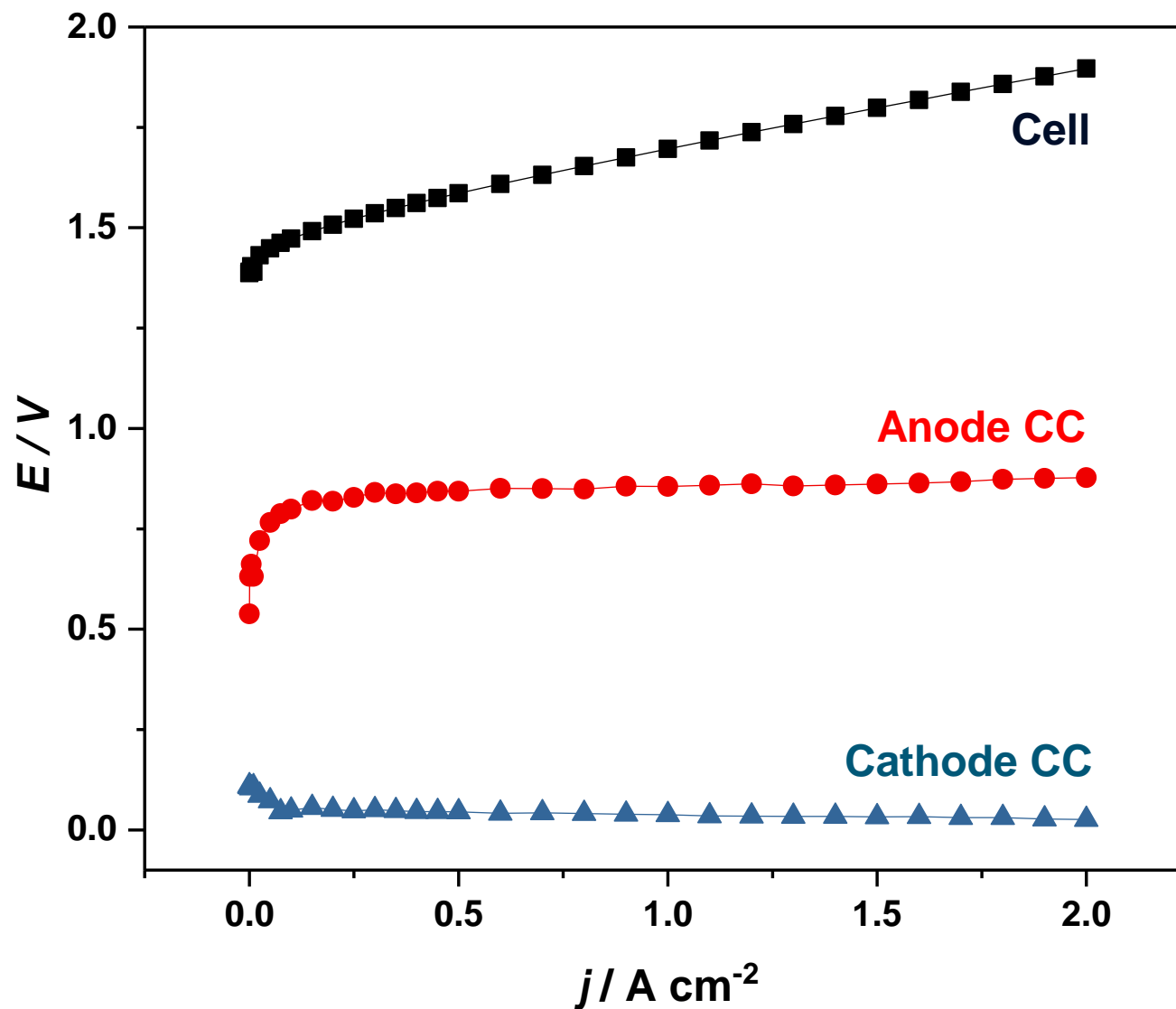
Driving force
for corrosion

In situ reference electrode measurements



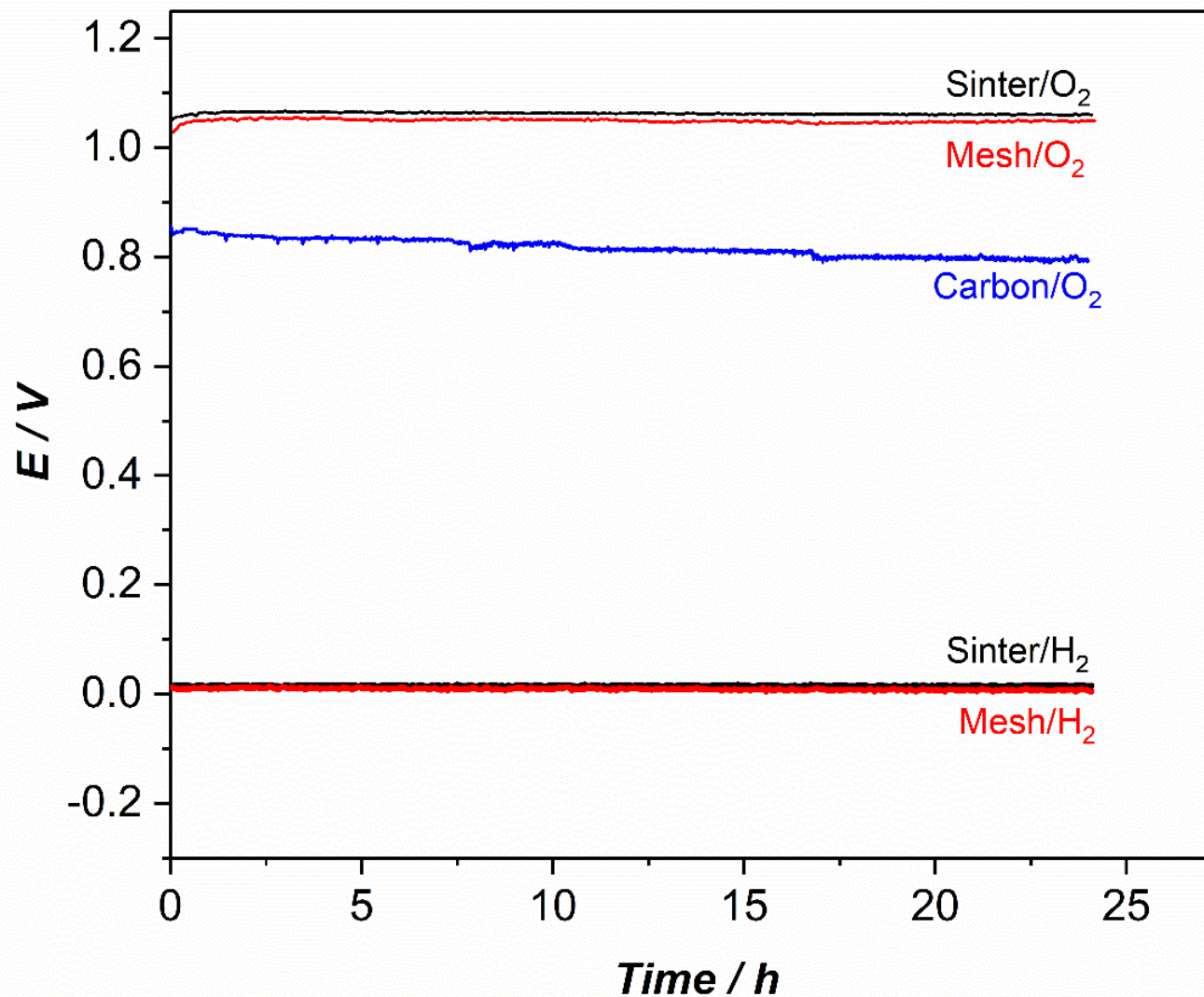
Driving force
for corrosion

In situ reference electrode measurements



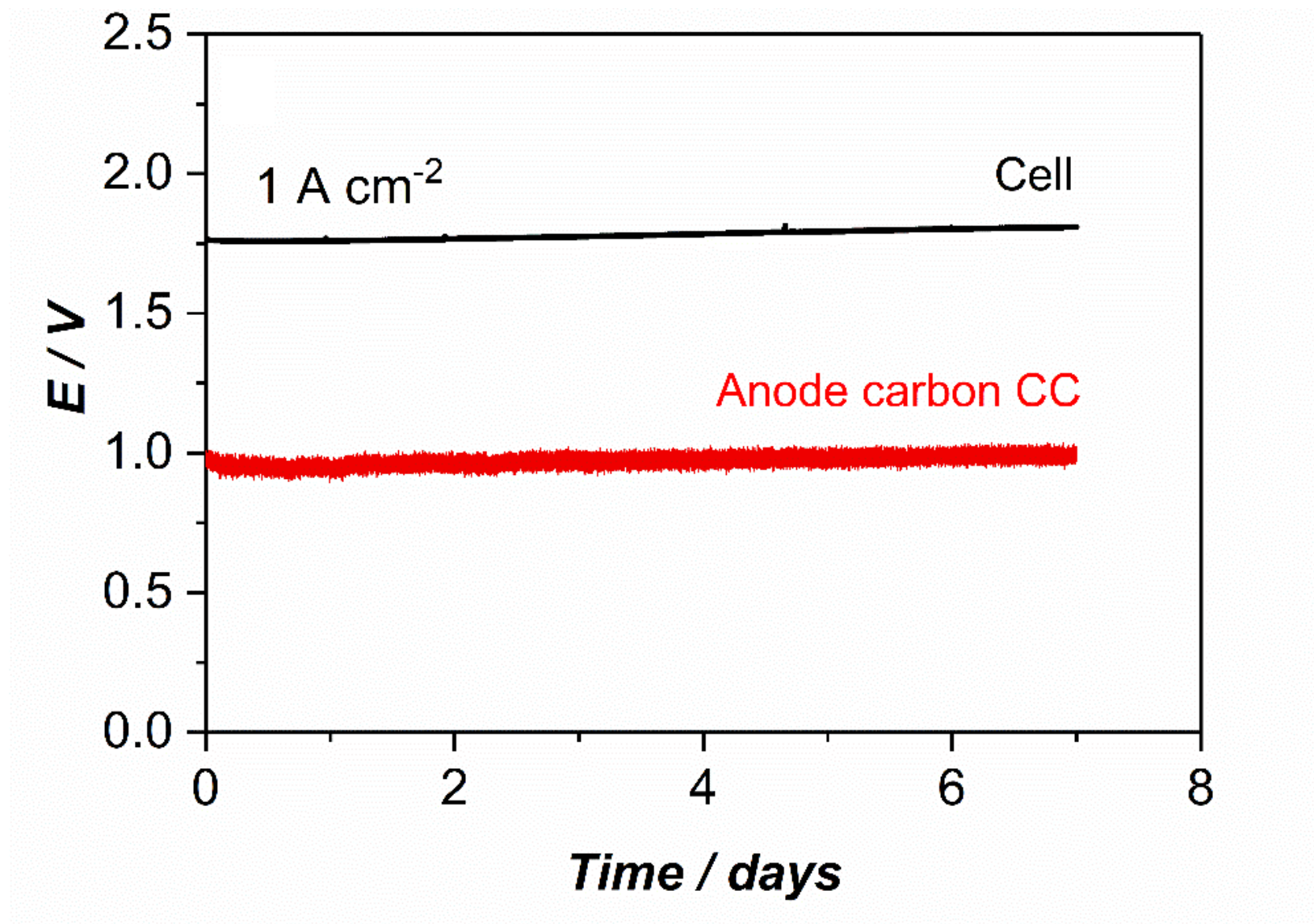
Driving force
for corrosion

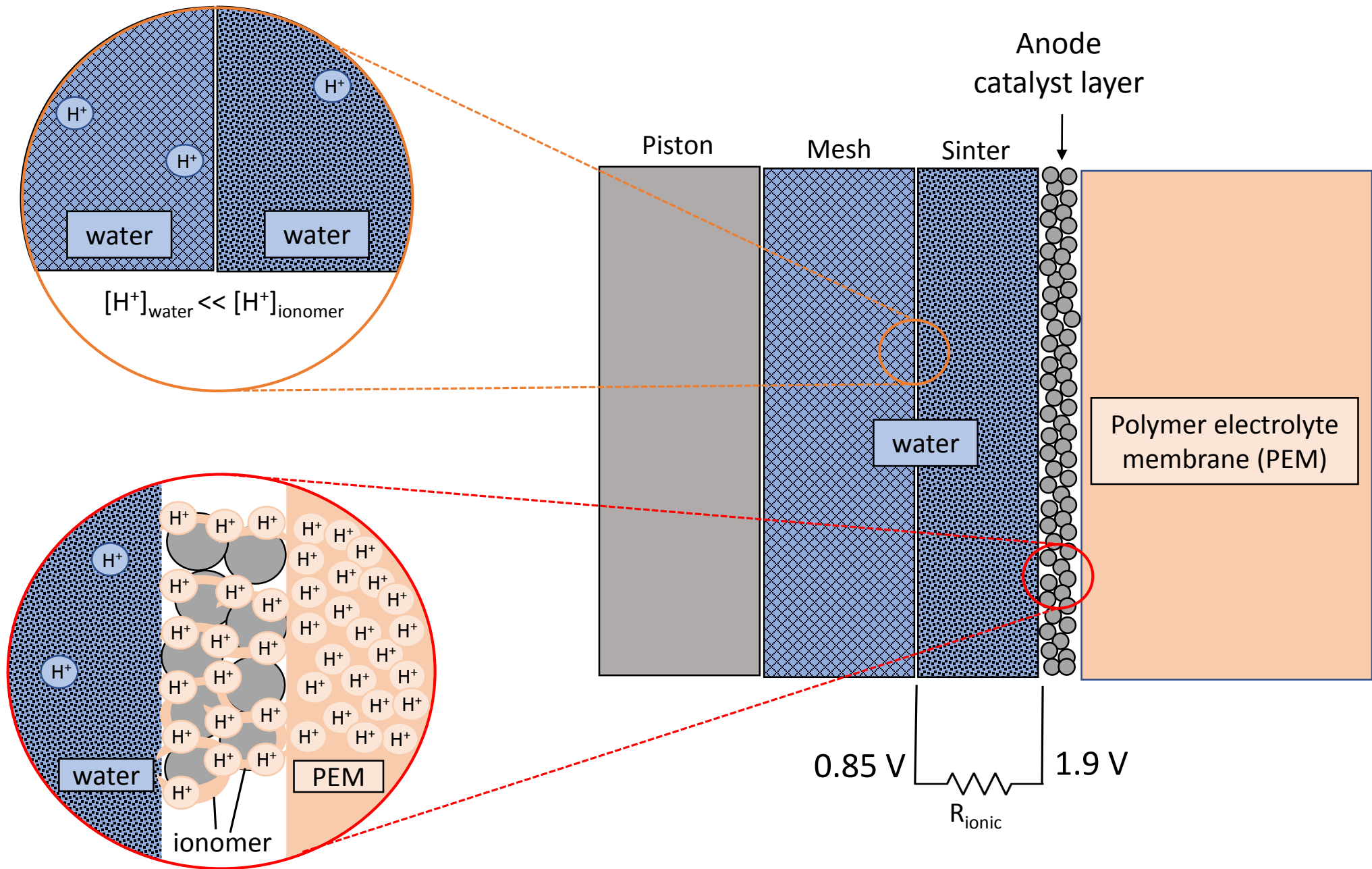
Ex situ reference electrode measurements



Dilute H_2SO_4 , pH 4.5, 60 °C

In situ reference electrode measurements





Summary & Implications

- Corrosion potential at the **current collector** during PEMWE operation is effectively **decoupled** from that of the nearest electrode due to the large potential drop in deionised water
- Opens up possibility of using **lower cost** materials than Pt and Ti for anode current collectors, e.g. carbon or carbon-coated stainless steel, with potential to reduce stack cost by up to **~ 50%**
- NPL is now supporting investigation of feasibility of design modifications to PEMWE stacks to incorporate this new perspective