METAL-SUPPORTED CERIA ELECTROLYTE-BASED SOFC STACK FOR SCALABLE, LOW COST, HIGH EFFICIENCY AND ROBUST STATIONARY POWER SYSTEMS

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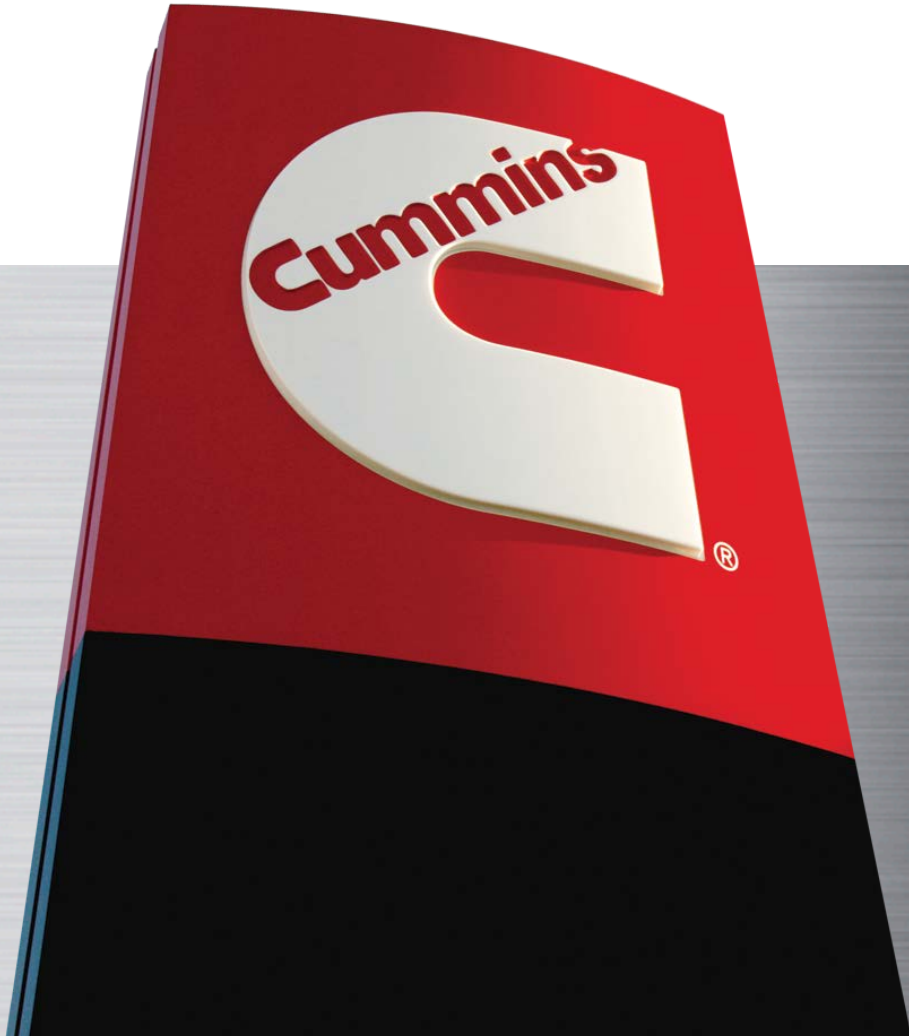


Agenda

- Cummins' emerging SOFC strategy
- Ceres SOFC pedigree & sample data
- FE27844 Objectives
- 5kW building block fundamentals
- Acknowledgements

Cummins' Market Segments aligned to Fuel Cells

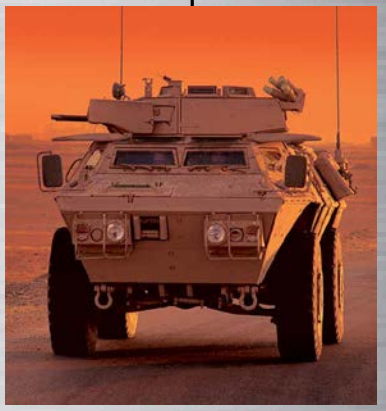
Mining

Marine

Oil & Gas

Rail

Defense



Consumer

Commercial & Industrial

Mission Critical

Prime Power

Components

Cummins Evaluation Of Data Center Applications

- Evaluation of Microsoft's vision for data centers of the future at small scale
- First phase of evaluation commenced October 2017
- Ceres and Cummins DoE demonstrator engineered for Microsoft's operational and physical targets

Ceres Power

- Unique Fuel Cell Technology
- 50 patent families
- 144 employees

World leading developer of SteelCell® low cost, non combustion power generation technology

- High efficiency distributed generation
- Lowers CO2 emissions
- Improves Air Quality
- Provides energy security
- Enables EV's and balances renewables
- Uses existing fuel infrastructure today, e.g. Natural Gas, bio fuels and H2 ready

DEVELOPMENT PARTNERS

- Honda Power Systems – several applications
- SOFC Stack to Extend Range of Electric Vehicles
- Data Centre & Commercial Scale Opportunity

CONFIDENTIAL PARTNER 1

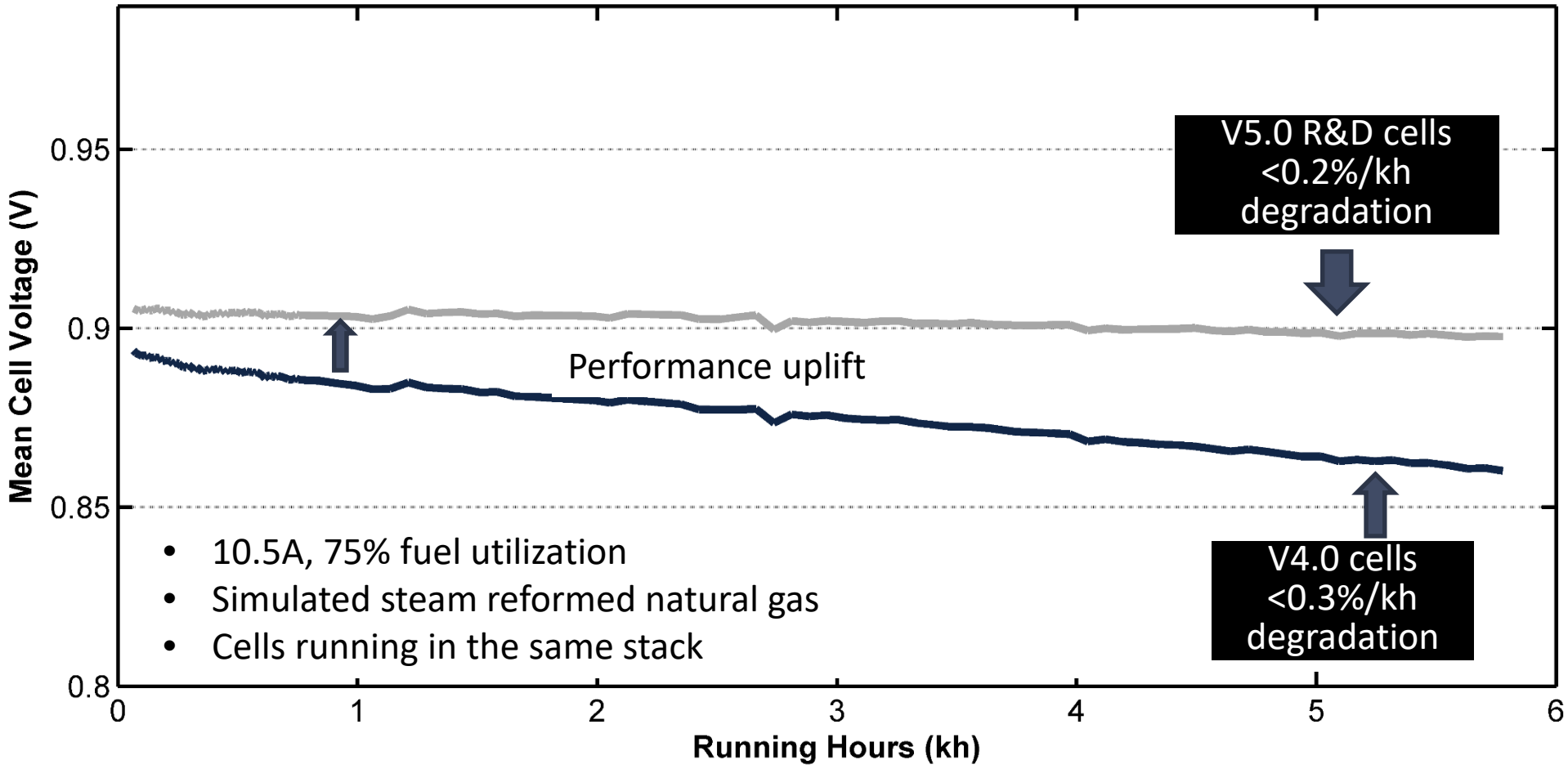
- Commercial Scale CHP Development with aim to market launch

CONFIDENTIAL PARTNER 2

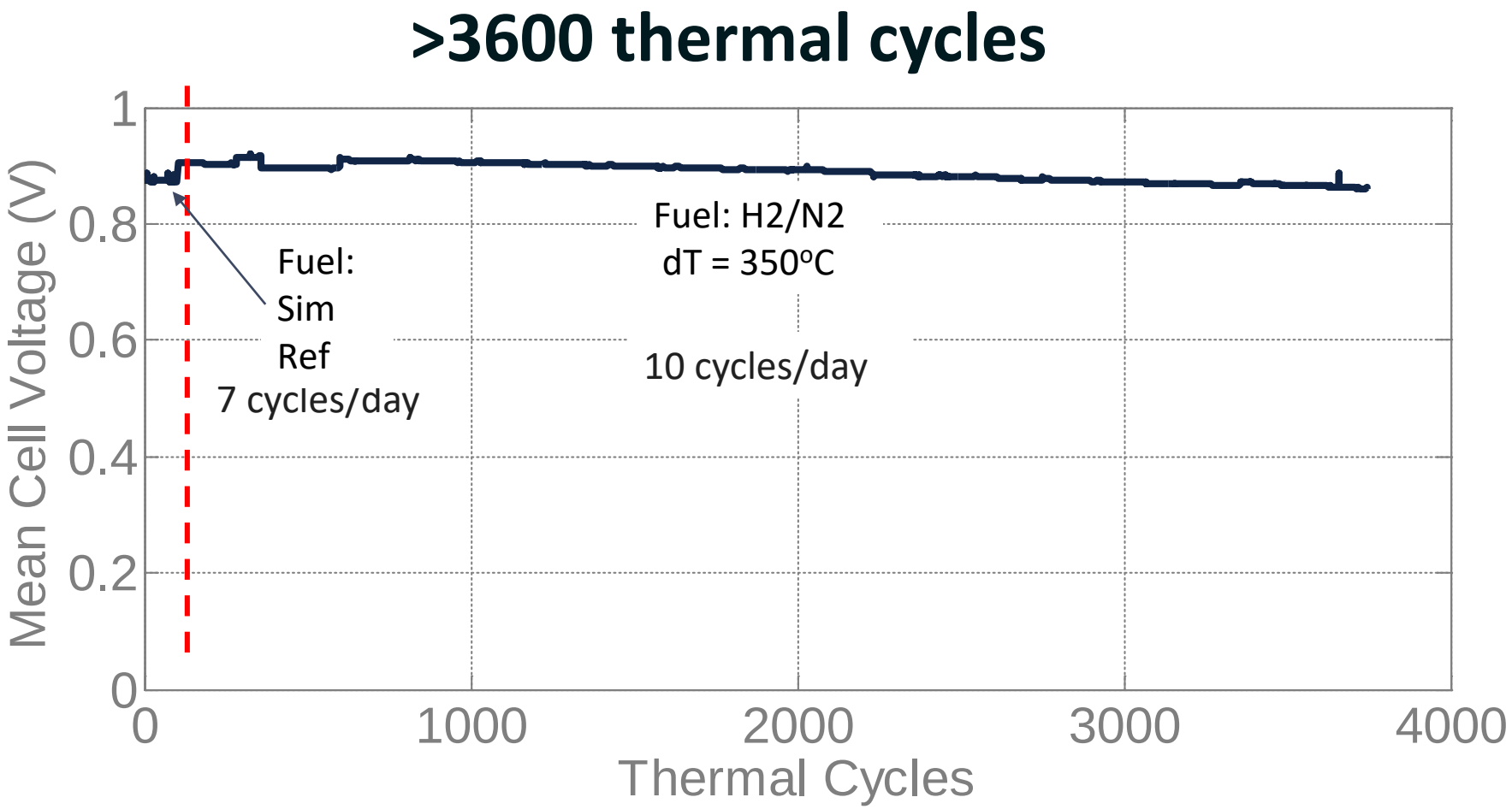
- European-based Global OEM co-developing multi-kW prototype for multiple applications

- Strategic collaboration – buses and other China markets - targeting equity investment and JV

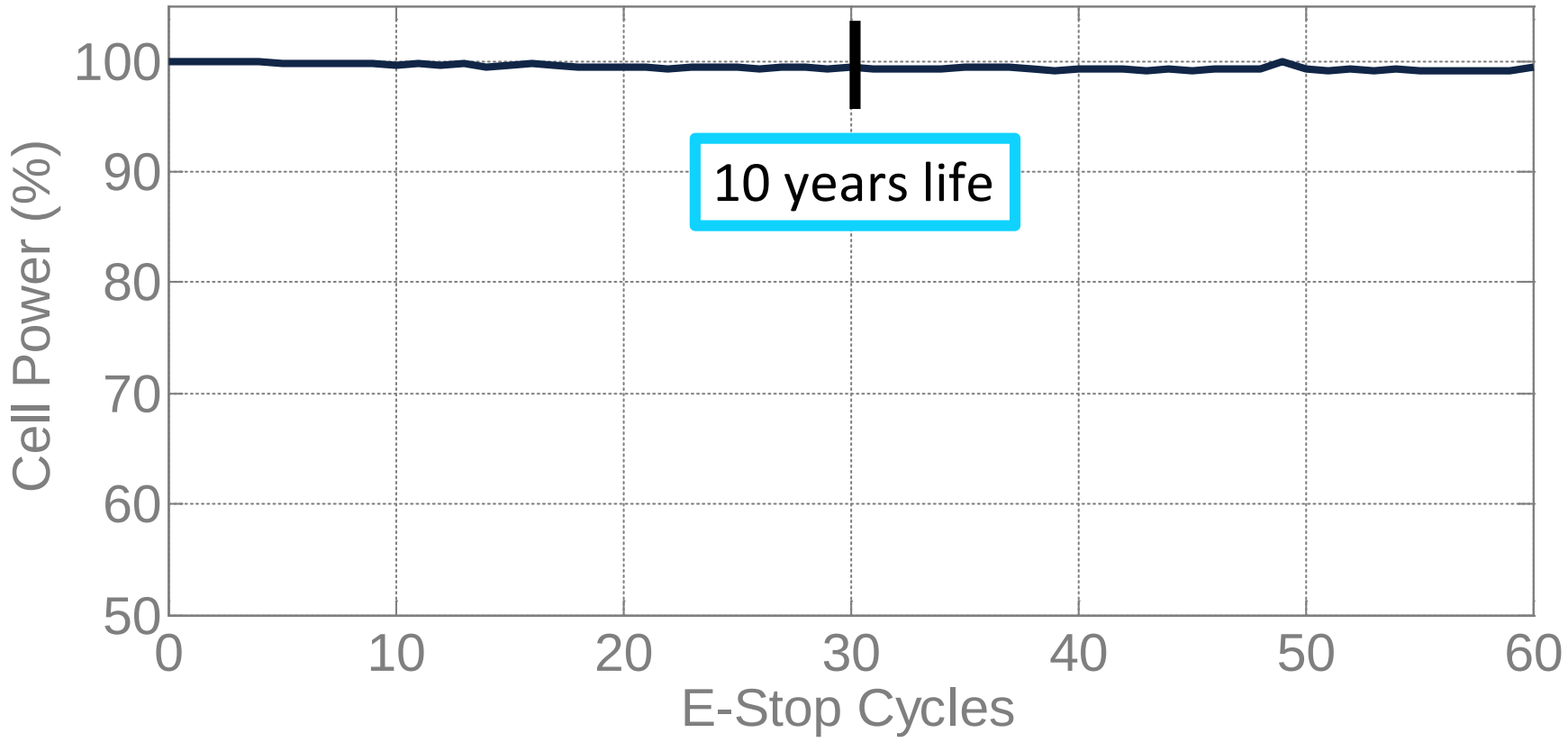
Version 5.0 Cell Technology Performance Uplift vs. Current Production Design



Steel Cell Stacks are robust to On-Off thermal cycles



Robustness to Redox cycles and E-stops demonstrates world class results

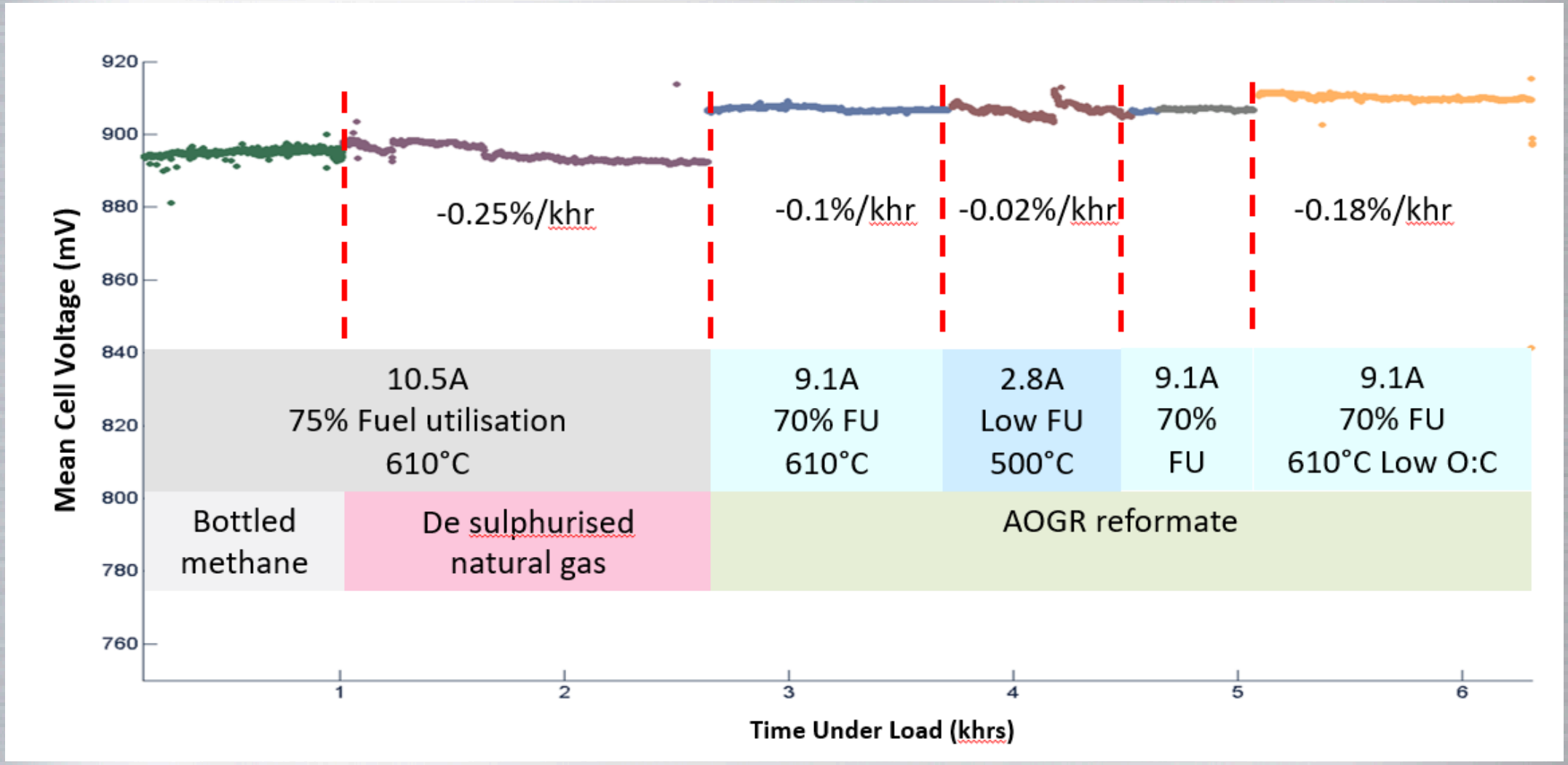


FE27844 Objectives

- Development of:
  - Complete internal fuel reforming capability — Complete
  - Larger active cell area to achieve integrated, compact, low cost 5kW stack — Complete
  - Integrated 5 kW modular stack platform scalable from 5 – 100kW — Complete
  - 5 kW FCPS demonstrator utilizing integrated 5 kW modular stack platform — Dec 2018
- Demonstration of:
  - 5kW FCPS performance through minimum of 1,000 hours of real-time testing:
    - Galvanostatic Degradation: <0.5%/1000hrs — Dec 2018
    - Robustness: >10 on/off cycles; >5 emergency stops (e-stops) — Dec 2018
- Cost modelling to show system cost of $1,500/kW (2011 currency basis) achievable at production volumes — In progress
- Predictive modelling using demonstration test results to show system lifetime robustness capability of:
  - Galvanostatic Degradation: <0.1%/1,000hrs — Complete
  - Robustness: >2,000 on/off cycles ; >60 e-stops — Complete
- Partnership with PNNL for anode poison sensitivity — In progress
- Partnership with UConn for cathode poison robustness — In progress

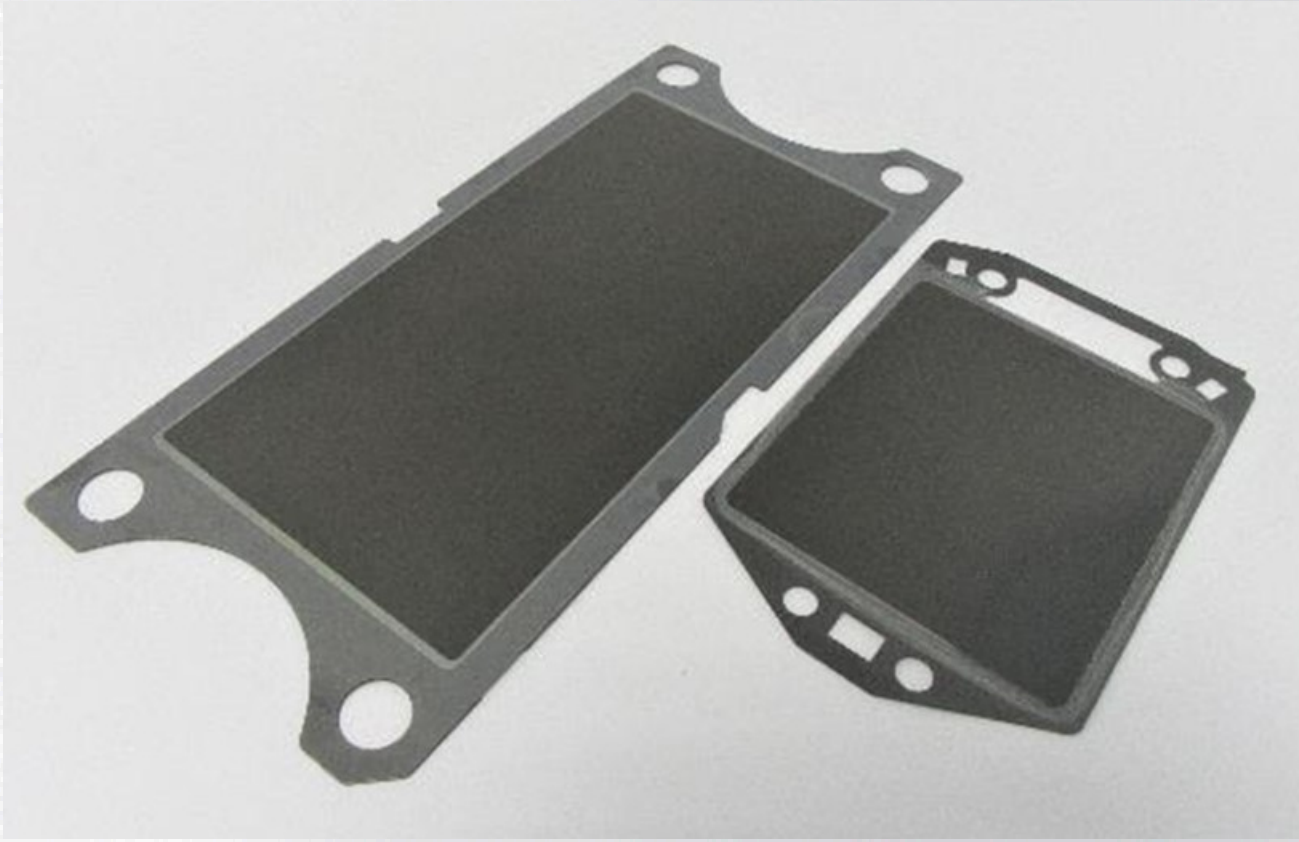
Internal Reforming Proven

Simulated 100%
Internal reforming



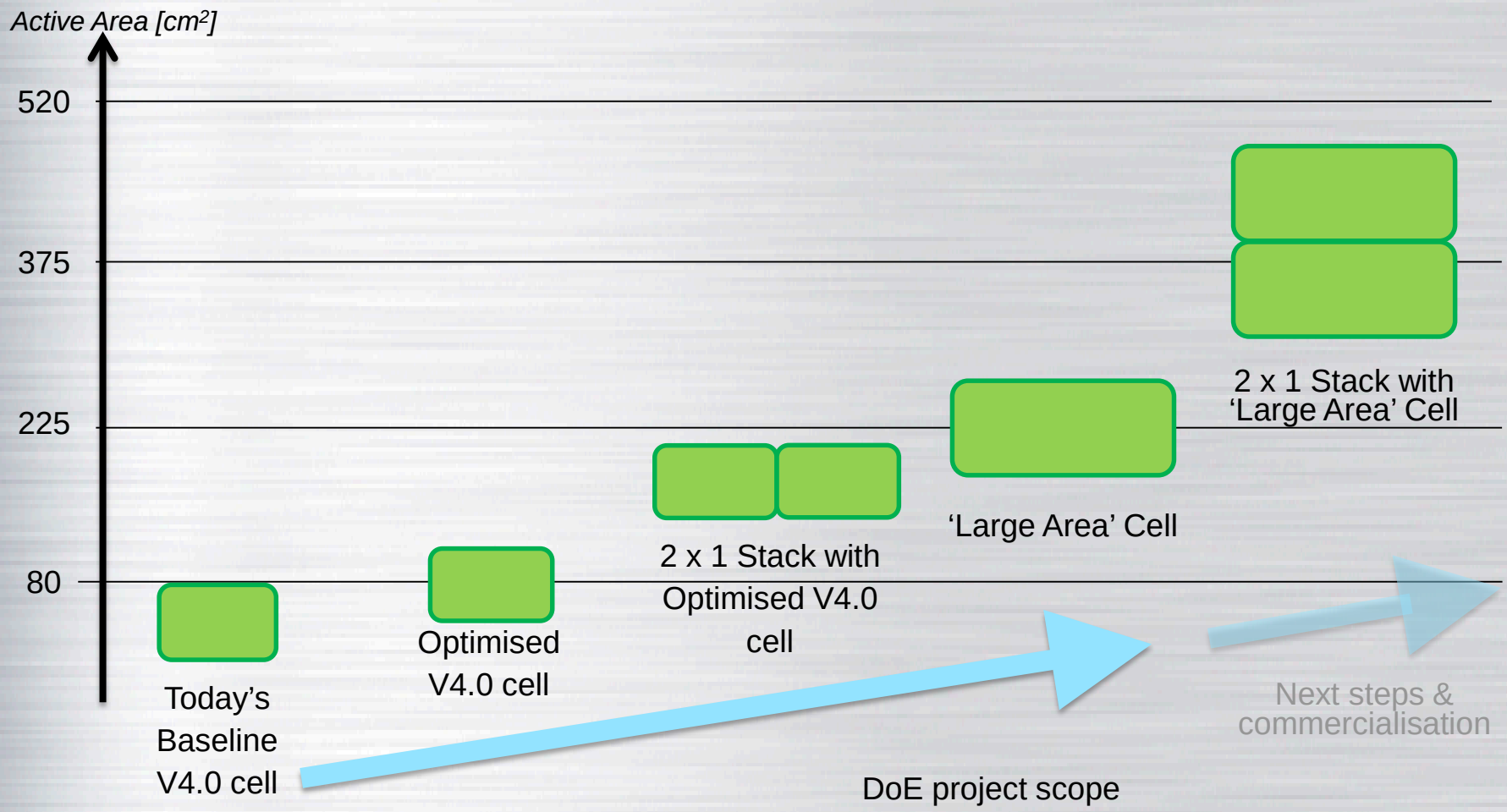
1kW Large Area Cell Prototype Short Stack Built & Tested

- Increase in active area is a factor of ~3 from the cell used in current stacks
- Fluid manifolds are designed for up to 250 cell layers in a stack
- First of a kind developed to prove concept



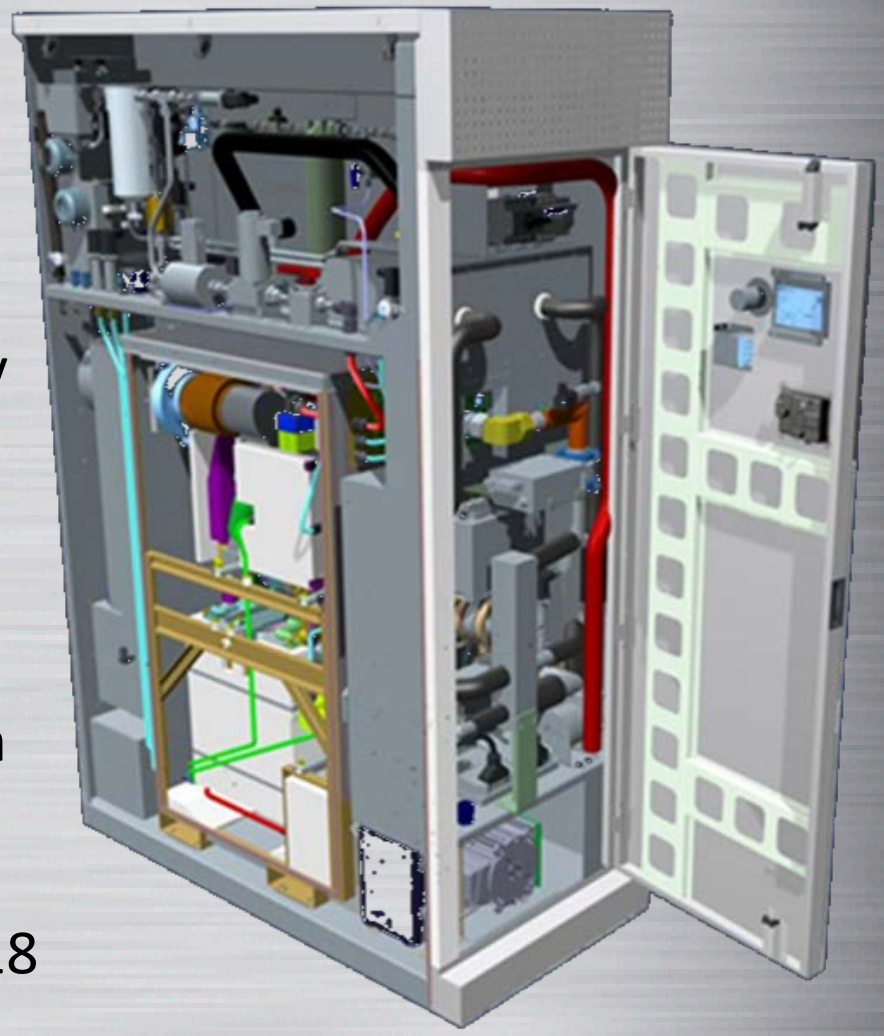
Larger Cell Area Roadmap

- Ceres plans a step by step approach to deliver larger area cells



DoE / Cummins Project Demonstrator

- 5kW stacks
- Data Centre compatible
- >60% electrical efficiency predicted
- Unit size : Depth 1.25m,
- Width 0.6m, Height 1.9m
- First Unit running Q3 2018



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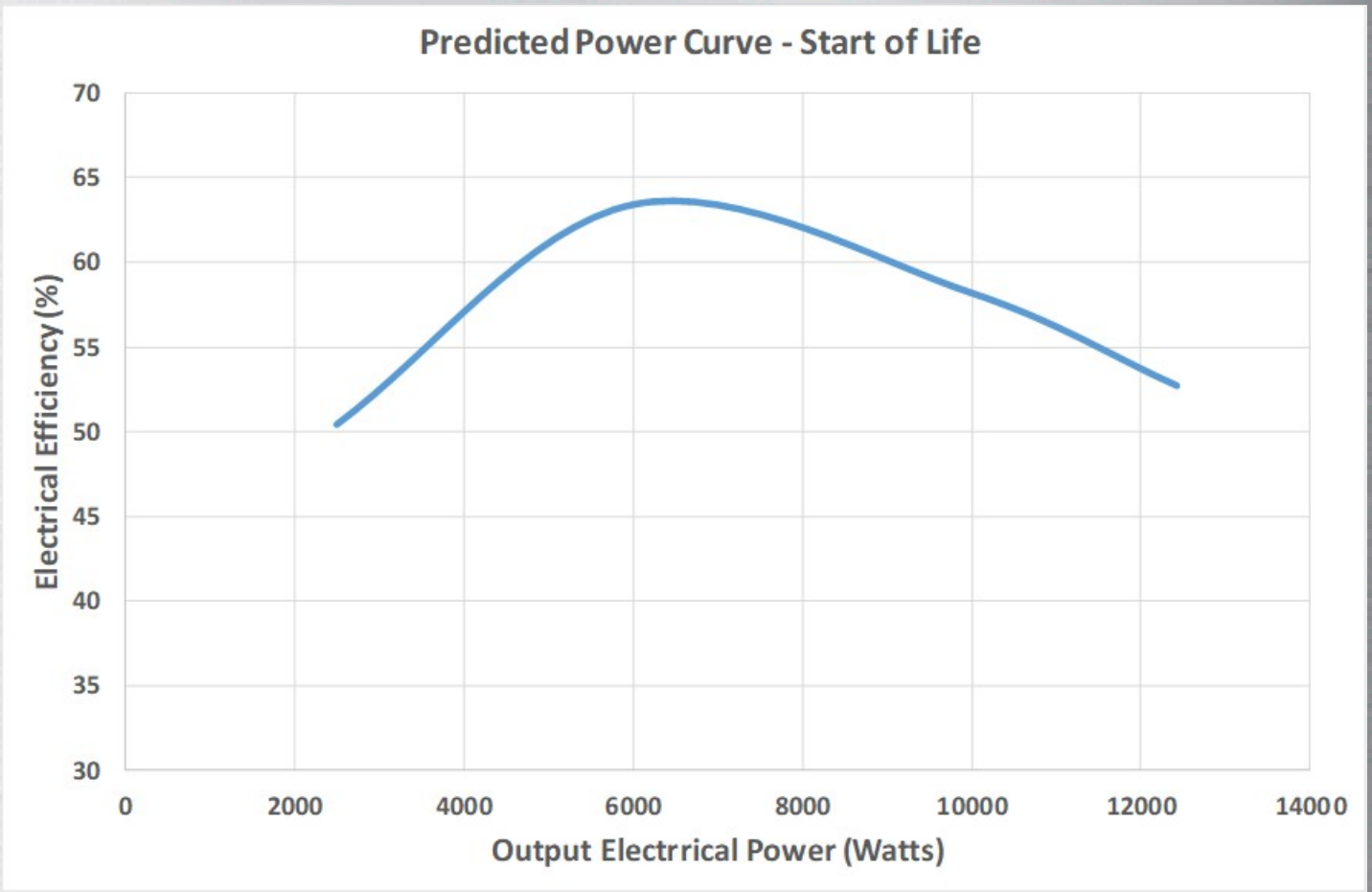
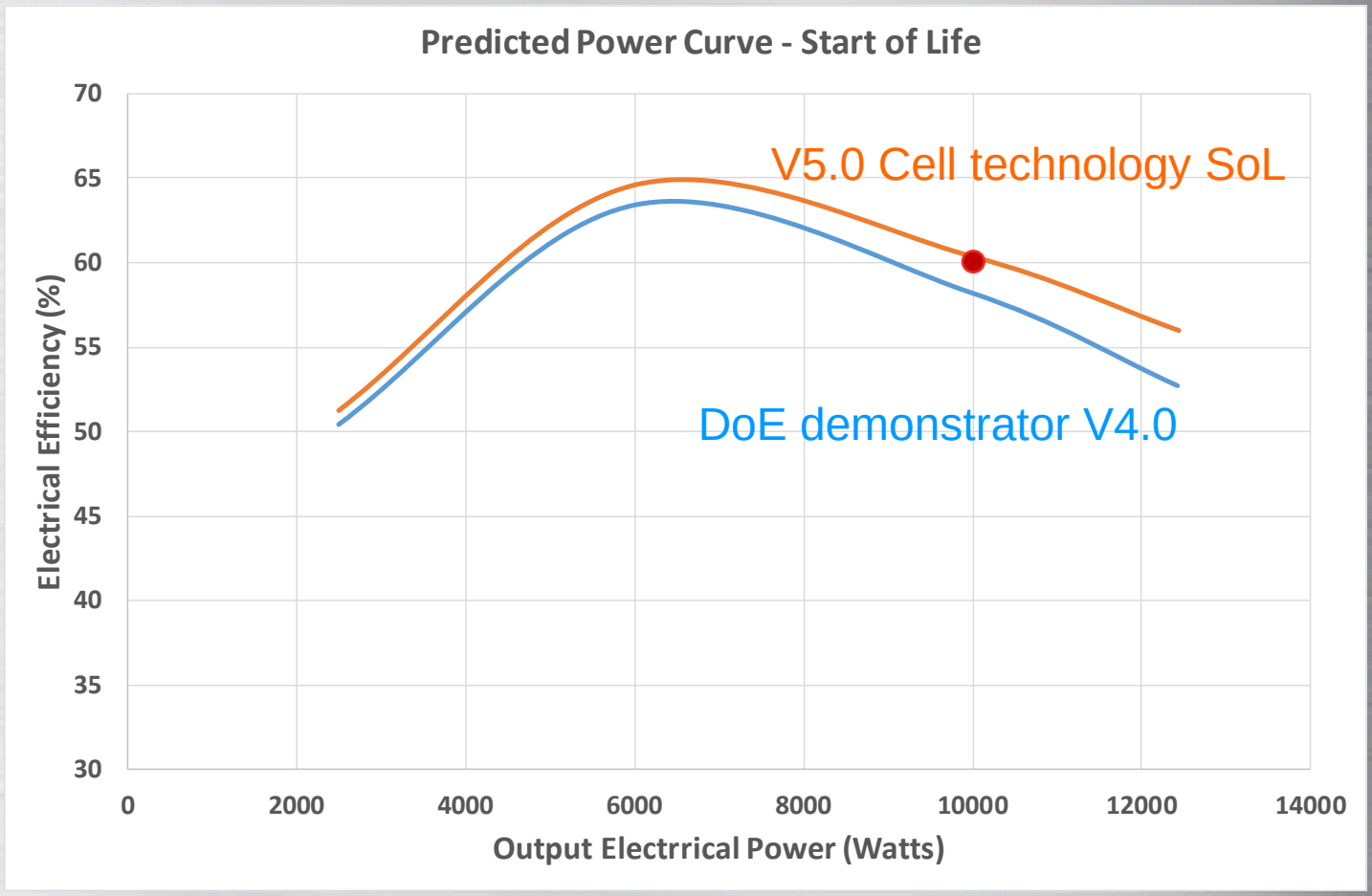
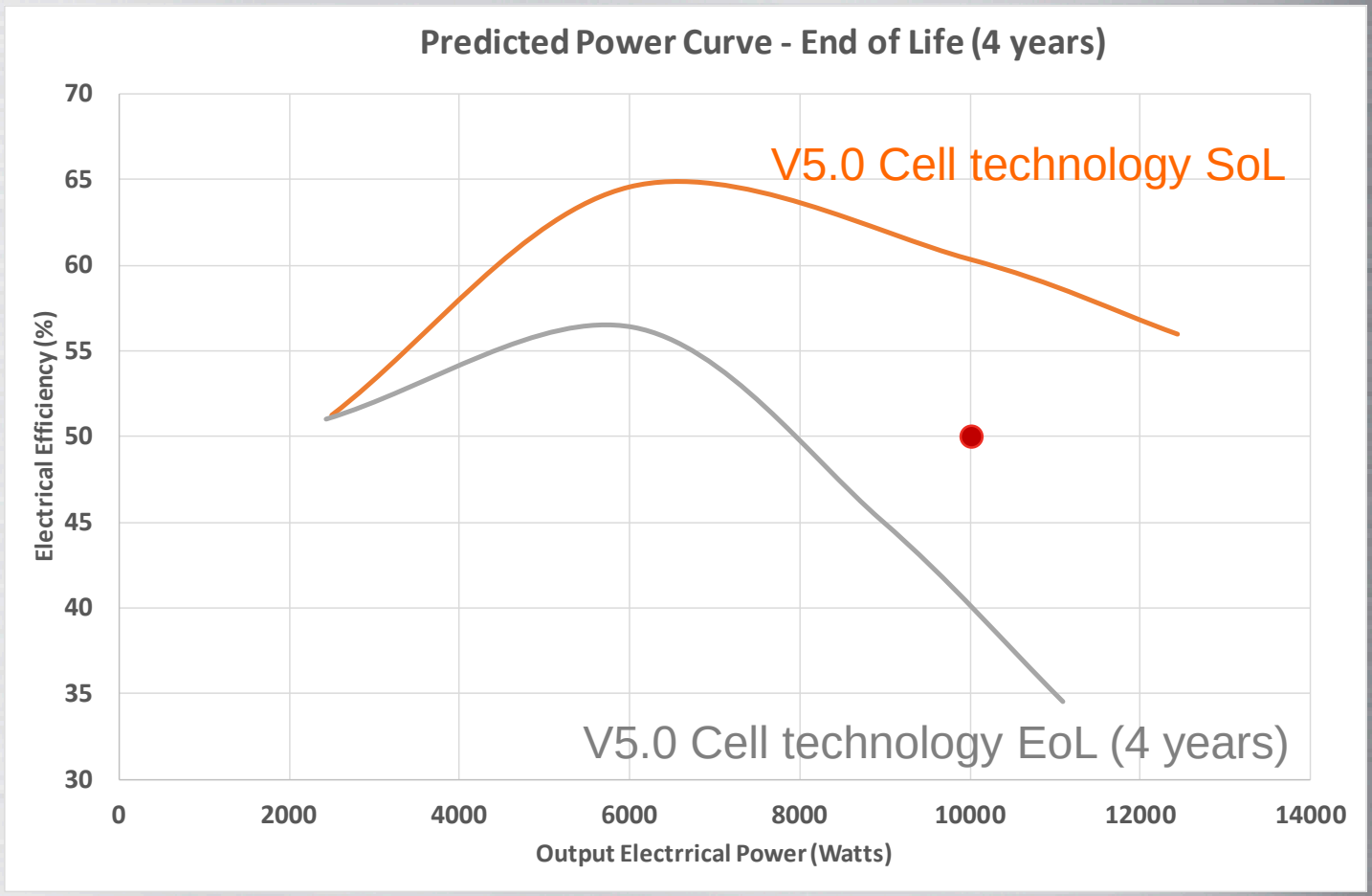


Upgrade Path Engineered in from the Get-Go



- Improvement from V5.0 cell technology
- Further improvement expected with system development

Next Gen Stacks Satisfy Microsoft Durability Targets

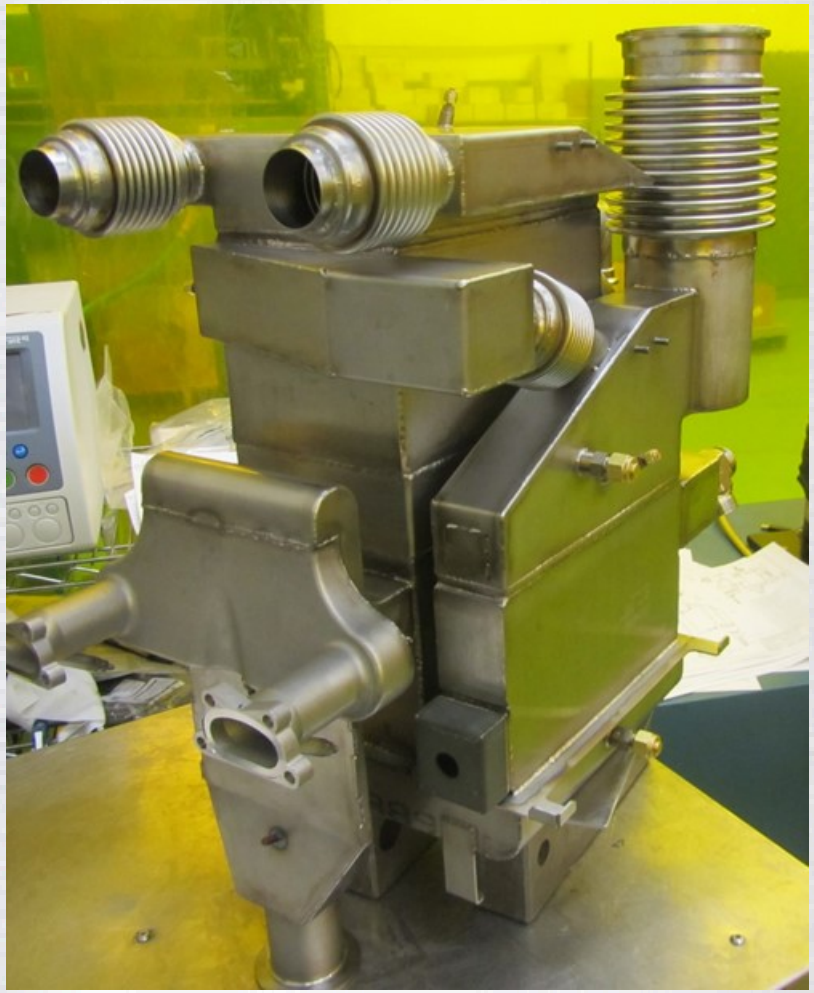


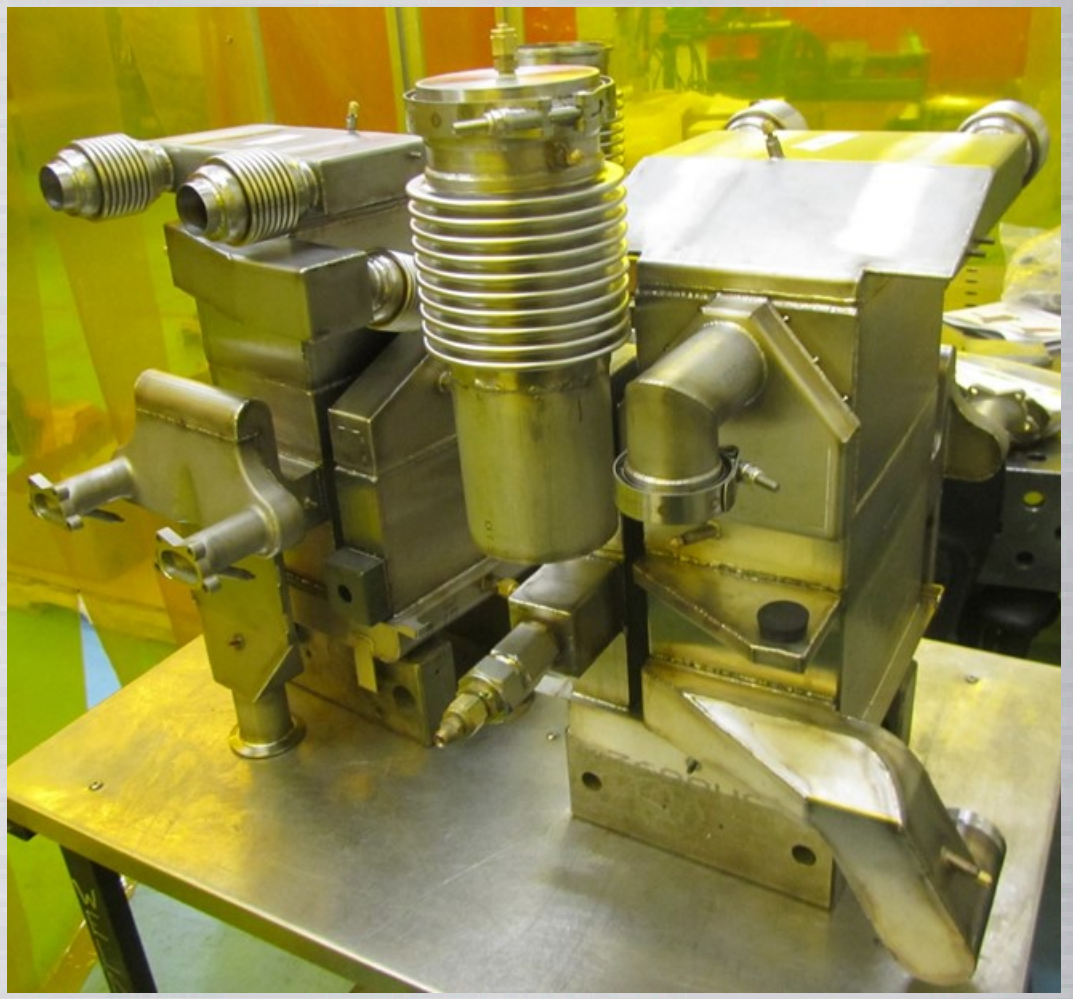
- Average rated power efficiency through life >50%
- Average end user efficiency through life >55%

Demonstrator System - Top Level Assembly

Hot Balance of Plant – Fuel Cell Module Weldments

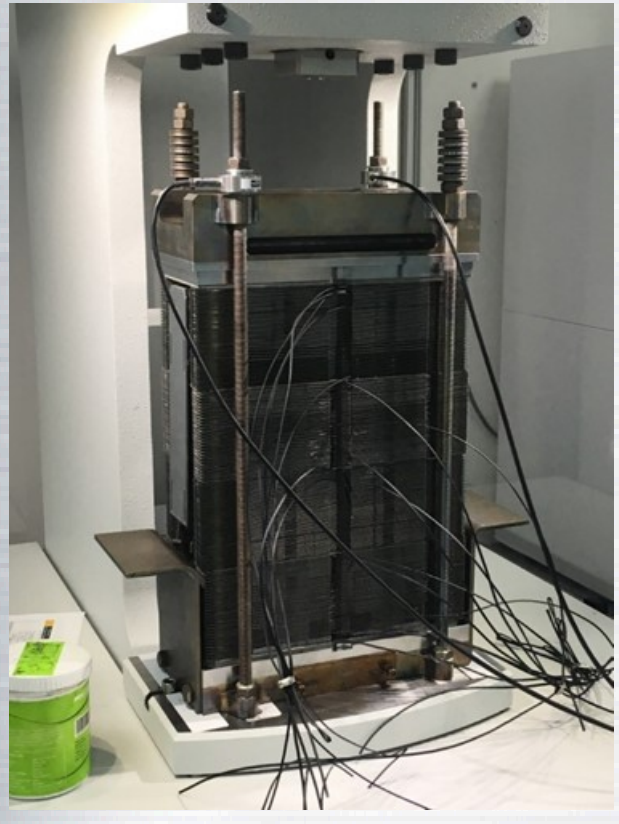
- PEKO Precision responsible for execution of detailed design & system build





5kW Stack

- 5kW Stacks now built and on test at CPL



Progress & Accomplishments

- Large area short stack designed built and tested
- Internal reforming proven
- Demonstrator system detailed design successfully completed with PEKO Precision
- PEKO Precision progressing system build for testing in Q3 2018
- Poison work progressing to plan with UConn & PNNL
- Good team working dynamic

Next Steps

- Complete demonstrator system build and shakedown
- Commission demonstrator system
- Complete demonstrator system evaluation at UConn
- Conclude cathode & anode poison work
- Continue to develop pipeline of activities beyond end of DoE project

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