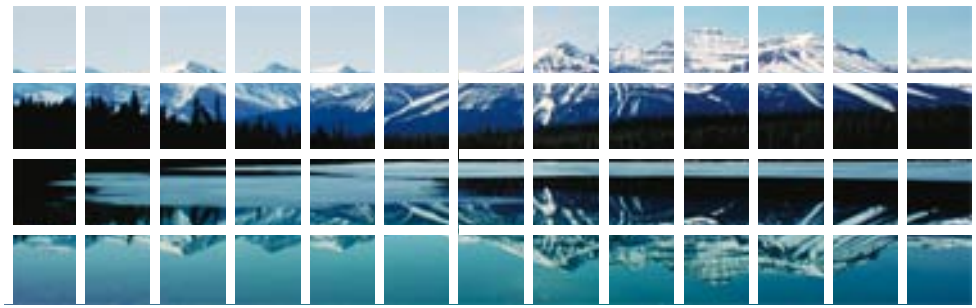

Ballard Power Systems

CUTE

A Fuel Cell Bus Project for Europe

Lessons learned from a fuel cell perspective

May 10 and 11, 2006

Outline

1. Background on Ballard Power Systems
    a. Brief History
    b. Technical Progress to Date
2. Current Status and Benefits
    a. Benefits of Fleet Programs to Fuel Cell Development
    b. Remaining Challenges stack
        a. Ballard road map
3. Future Development
    a. Ballard's Next Generation Fuel Cell Stack
    b. Future Development of Fuel Cells
    c. Path to Commercialisation
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History of Ballard Power Systems

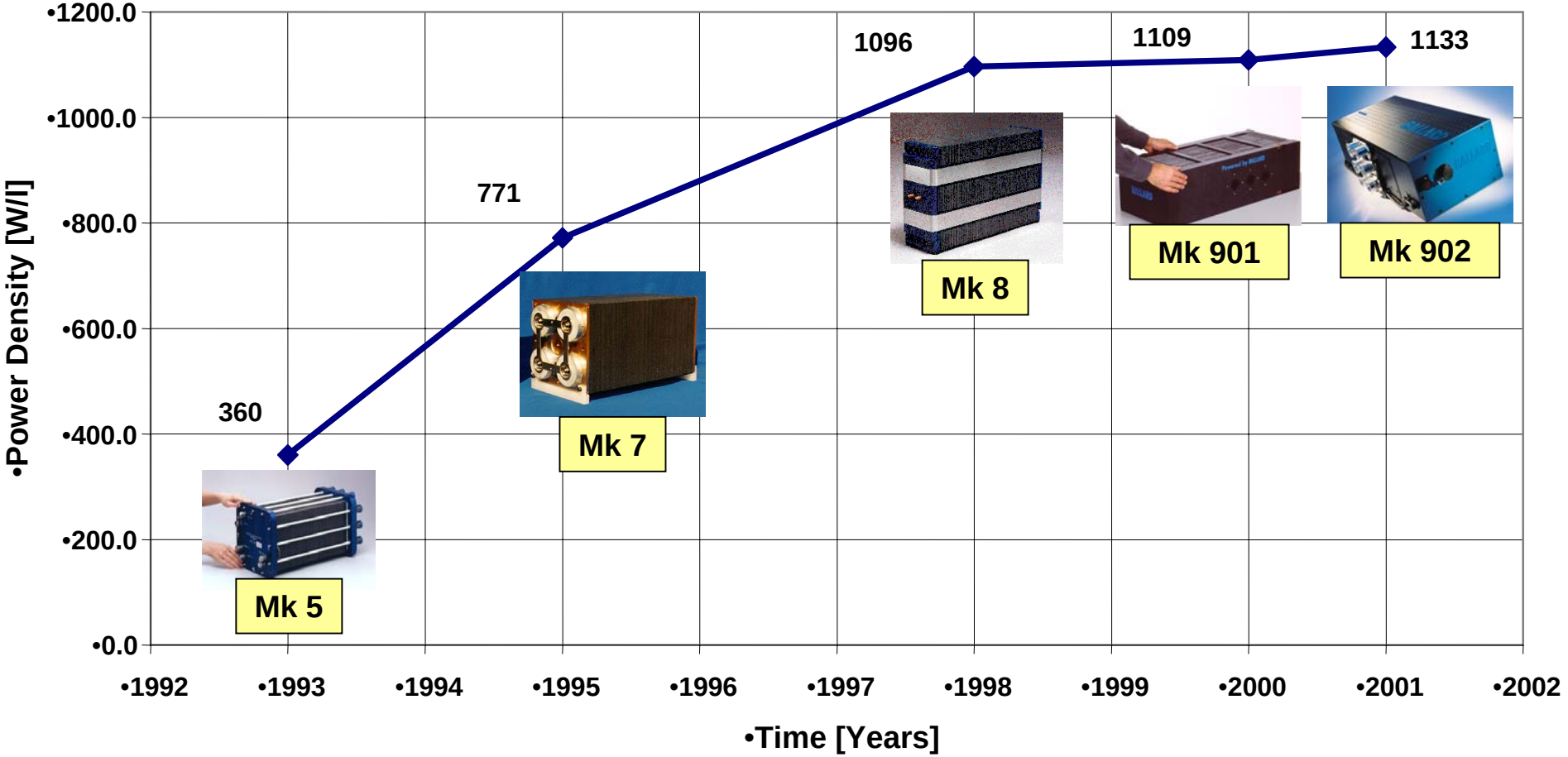
BALLARD®

- Founded in 1979 under the name Ballard Research Inc. to conduct research and development in high-energy lithium batteries.
- In 1983, Ballard began developing proton exchange membrane (PEM) fuel cells.
- Proof-of-concept fuel cells followed beginning in 1989.
- From 1992 to 1994, sub-scale and full-scale prototype systems were developed to demonstrate the technology.
- To date, Ballard has supplied fuel cells for over 130 fuel cell vehicles in 24 cities worldwide, including the CUTE, STEP, China, and California fleet bus programs, and Daimler Chrysler, Ford, and Honda automotive fleets.
- Ballard also builds fuel cells for non-automotive and stationary applications.

Ballard's Fuel Cell Progress

BALLARD®

•Power Density [Watts/litre] of Ballard's Fuel Cell Products



Mk902 LD and HD Stacks

BALLARD®

- Based on Light Duty (LD) automotive stack architecture
- Cell active area and terminal voltage sized for automotive application.
- Modular design designed for ease of repair.

Mk 902 LD	Mk 902 HD
4 cell row	6 cell row
440 Cell	960 Cell
85kW/300A	150kW/240A

MK902 Light Duty (LD)

MK902 Heavy Duty (HD)

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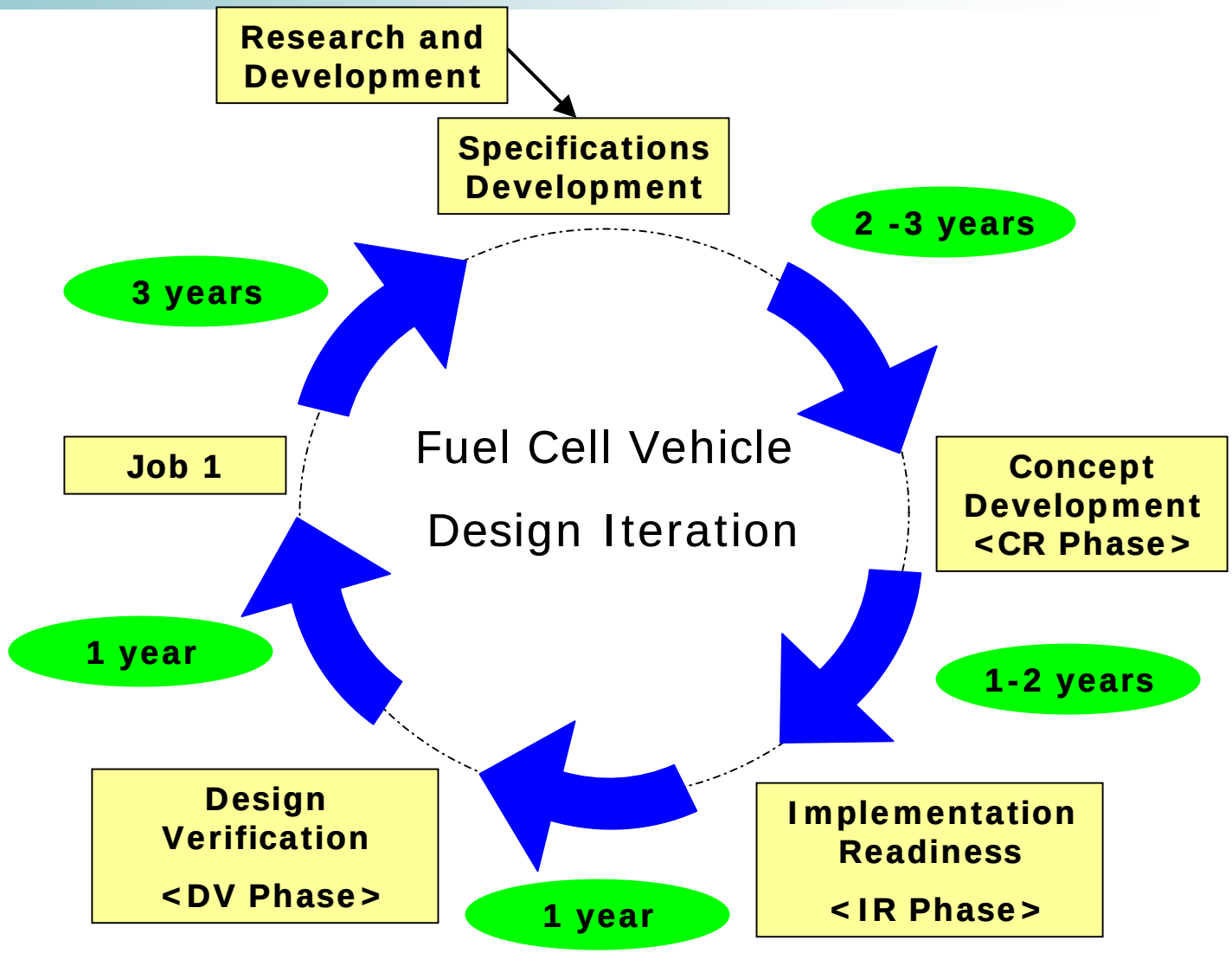
Fuel Cell Vehicle Design Cycle



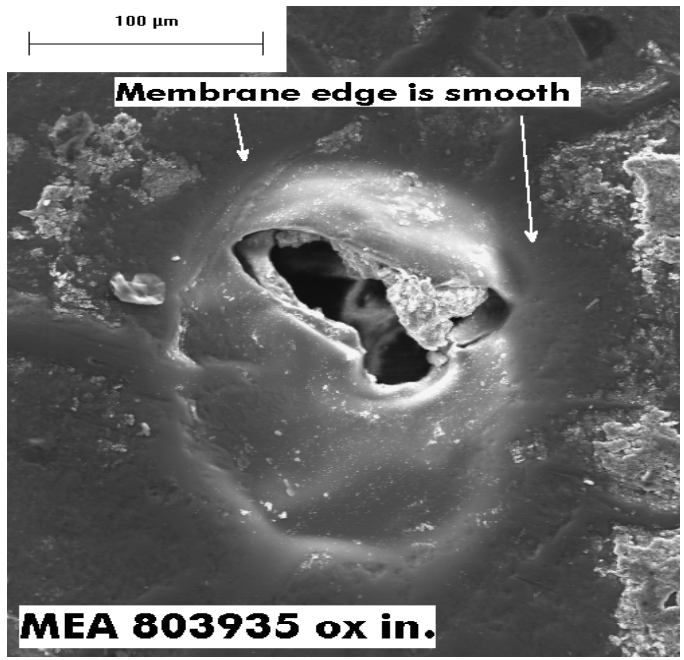
Total km & Hrs for CUTE/ECTOS/STEP Programs

BALLARD®

- As of April 21, 2006
- **1,223,881.6 km**
- **85,100 hours**
- Operation hours have allowed Ballard to gain insight to single cell operating characteristics, and performance durability.
- Ballard has accumulated over **110 Gigabytes** of fuel cell data during the CUTE Program.

Mk902 – Failure Modes

- Principle failure mechanisms of the Mk902
  - Leaks
    - Chemical attack of membrane
    - Contaminants in plates
    - Fatigue
  - Performance Loss
    - Corrosion
    - Catalyst damage
  - Low Cells
    - Random failure modes leading to localized damage



Benefits of Fleet Programs to Fuel Cell Development

BALLARD®

- Generation of “real-world” data not available from labs.
- Large data set helps identify and eliminate short, medium, and long-life failure modes.
- World-wide exposure of fleets enables fuel cells to operate in numerous driving and environmental conditions. This leads to improved fuel cell designs and more realistic driving simulations in the laboratories.
- Development of support industry and training of maintenance and support workers.

Benefits of Fleet Programs to Fuel Cell Development

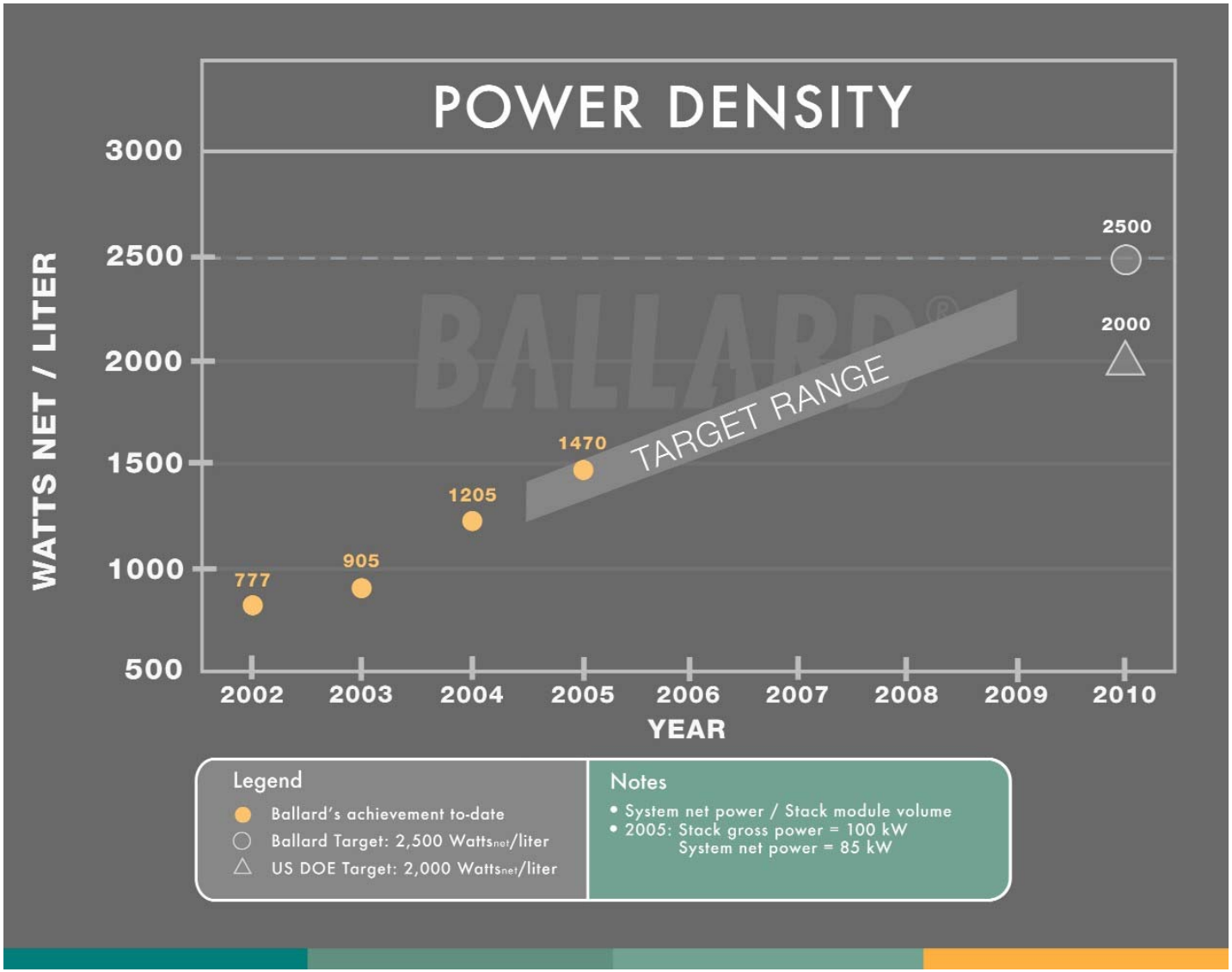
BALLARD®

- Fleet programs provide validation of environmental regulation implementation schedules.
- Data gathered from fleet vehicles allows for advances and changes in codes and standards for safety and certification (ex. Hydrogen emission standards - SAE J2578).
- Operating conditions, specifications, and test methods can be applied to other automotive and non-automotive fuel cell applications.

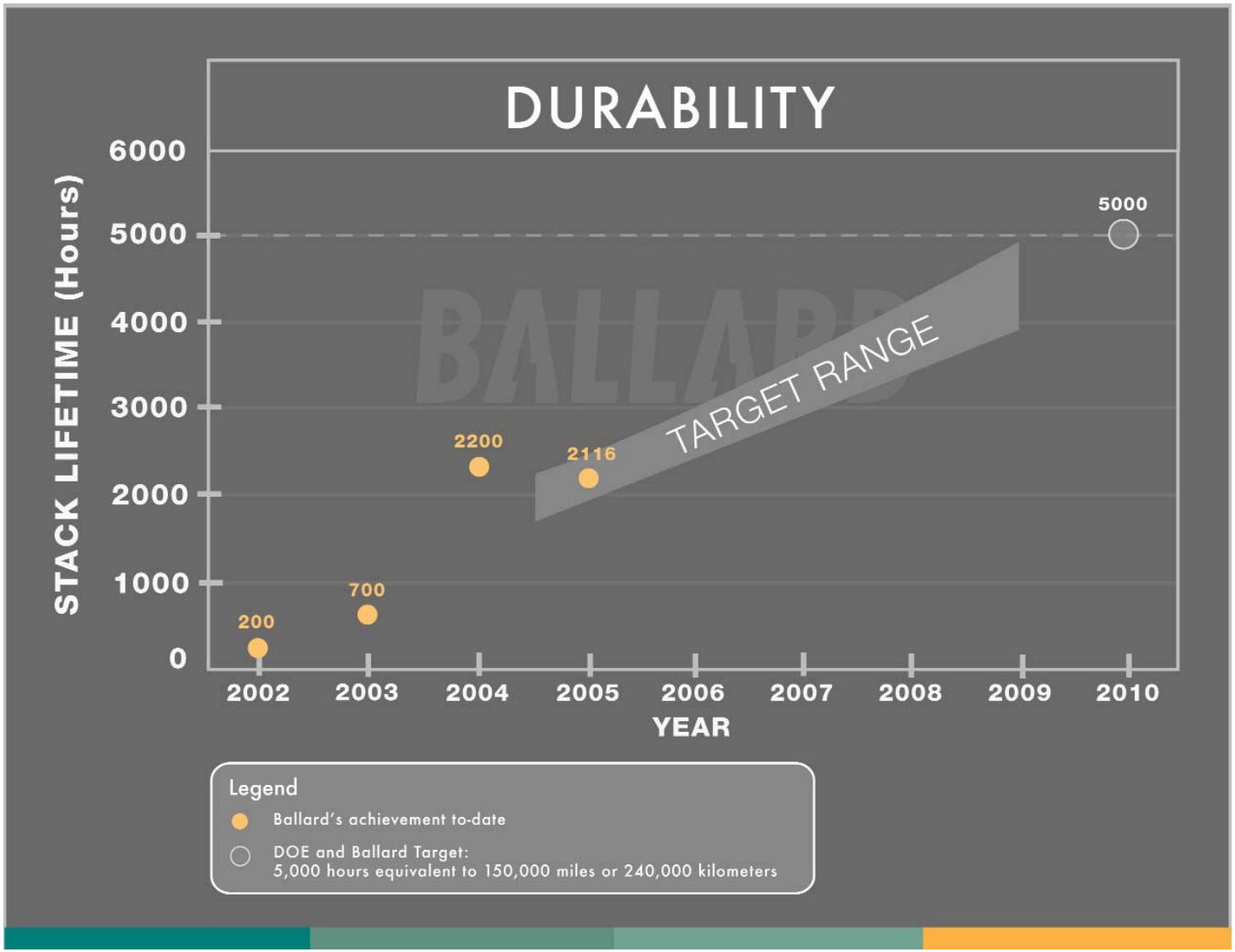
Stack Manufacturing Lessons learned from CUTE program

- The CUTE Program provided the largest product sample size to gather fuel cell information in Ballard history.
- Total Membrane Electrode Assembly's (MEA's) produced 80,000
- Manufacturing processes improved
  - Testing (tests times and test equipment)
  - Repairs (repair times and repair equipment)
  - Failure Analysis (failure software and sample sizes)

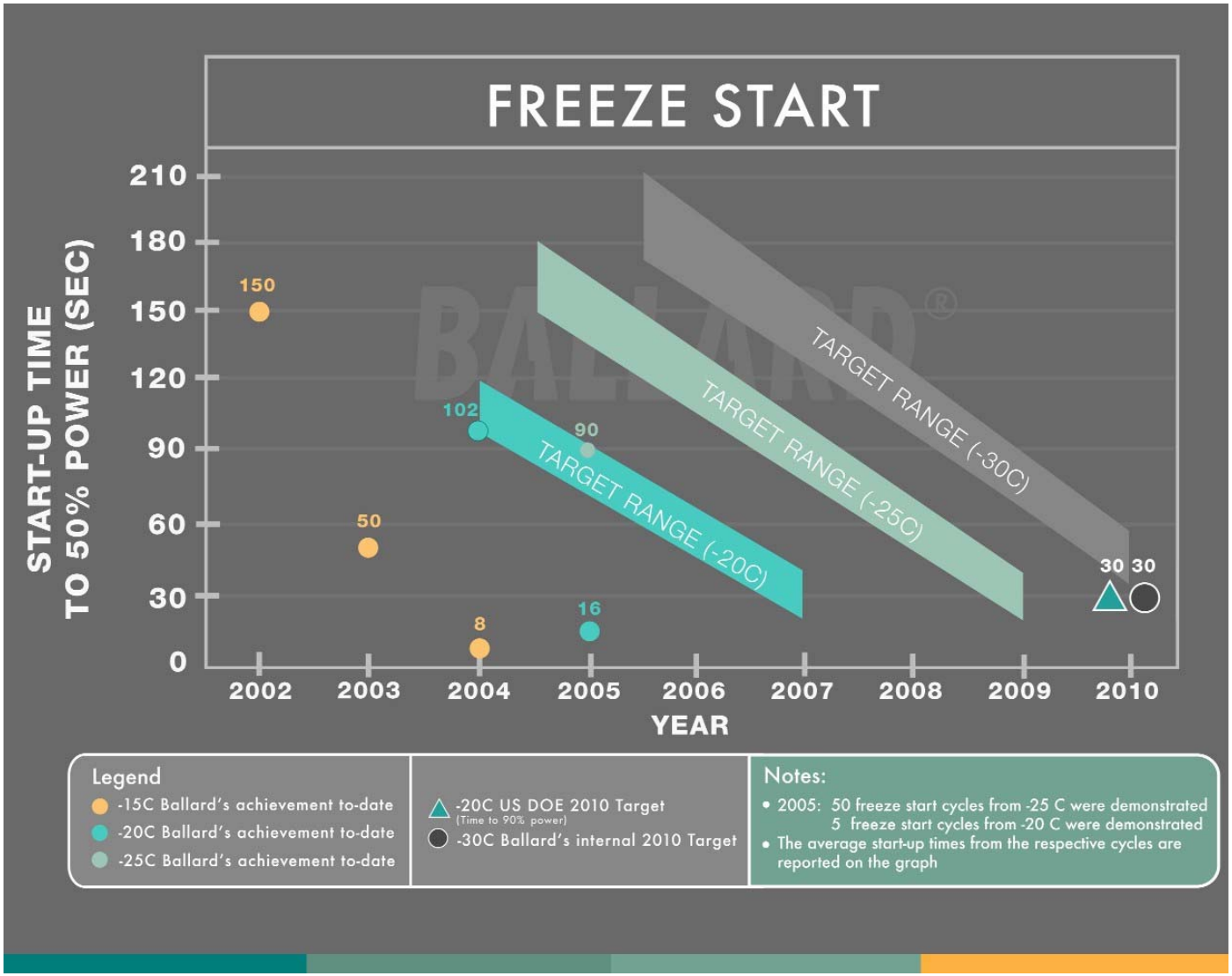
Remaining Challenges
Stack Power Density



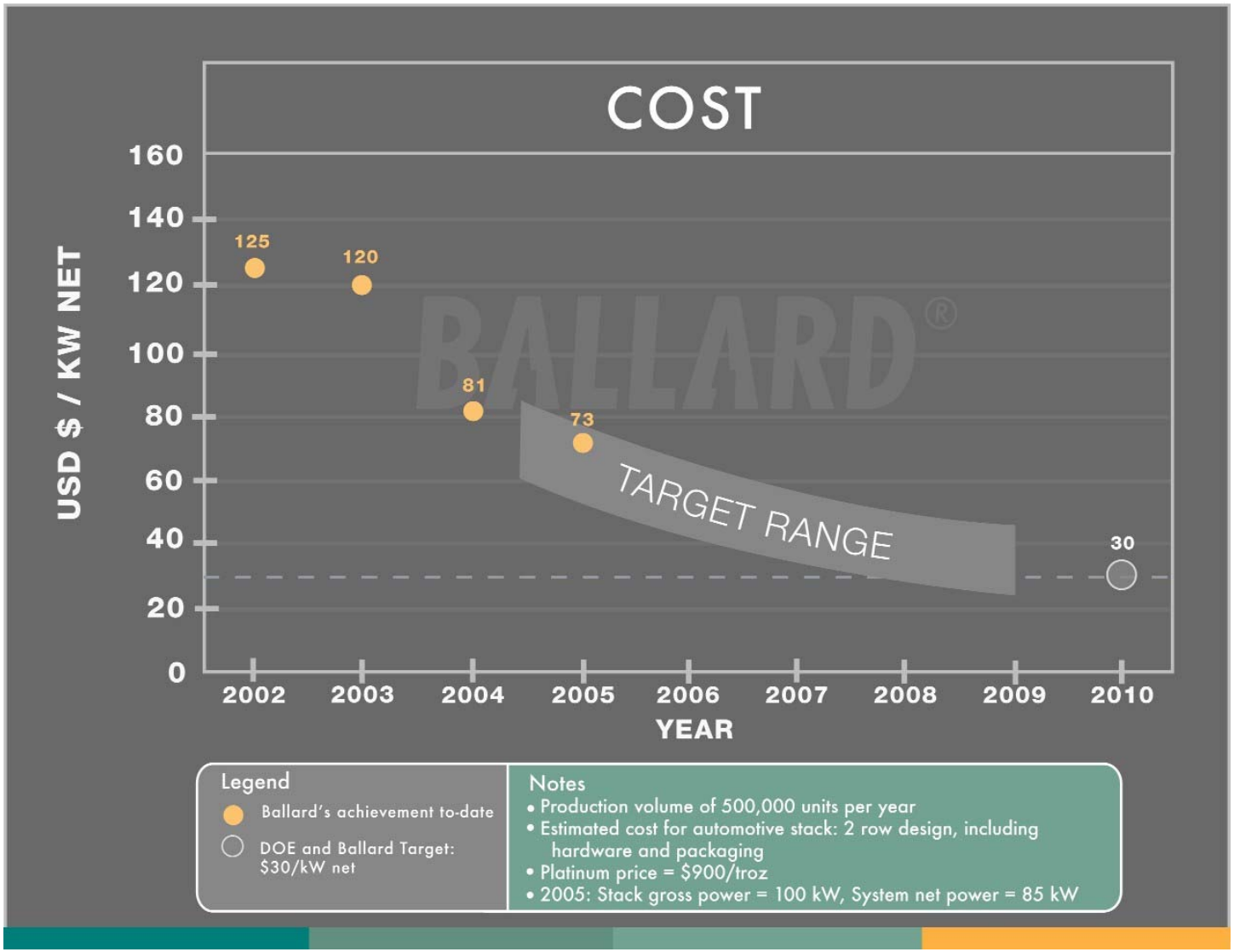
Remaining Challenges
Durability



Remaining Challenges
Freeze Start



Remaining Challenges
Cost



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Next Generation Improvements

BALLARD®

1. Power Density Improvements
   - Improved catalysts
   - Lower cell pitch
   - Higher cell performance

2. Improved Durability
   - Membrane improvements
   - Catalyst improvements
   - Seal material improvements

3. Freeze start capability

4. Higher temperature operation

5. Lower relative humidity operation

6. Lower cost
   - Higher cell performance requires less material
   - Lower cost materials

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Concluding Remarks

1. Background on Stack Development
   - Ballard has been developing PEM fuel cells since 1983.
   - Numerous developments been achieved since then and much more needs to be done.
2. Current Status and Benefits
   - Fleet programs generate data that enables learning which can be applied to future fuel cell designs.
   - The current design shows many advances, but is not optimal.
3. Future Development
   - Ballard's next generation fuel cell has progressive technology improvements aligned with long term targets established by governments and industry.
   - Achieving the long term targets will demonstrate a commercially viable automotive fuel cell design in 2010.

Concluding Remarks

1. Background on Ballard Power Systems
   - Ballard has been developing PEM fuel cells since 1983.
   - Ballard fuel cells have made huge gains in power density since 1993.
2. Current Status and Benefits
   - Fleet programs generate real on road data in copious amounts, which enables learning that can be applied to future fuel cell designs.
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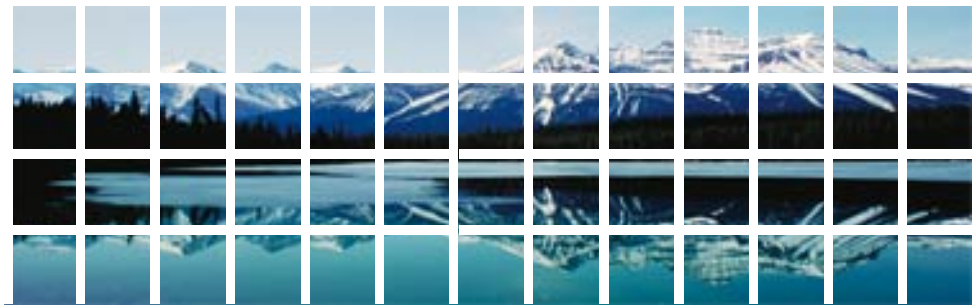

Thank You