

Dept. of Energy - Office of Fossil Energy Solid Oxide Fuel Cell Program



Ohio Fuel Cell Symposium
March 31, 2017

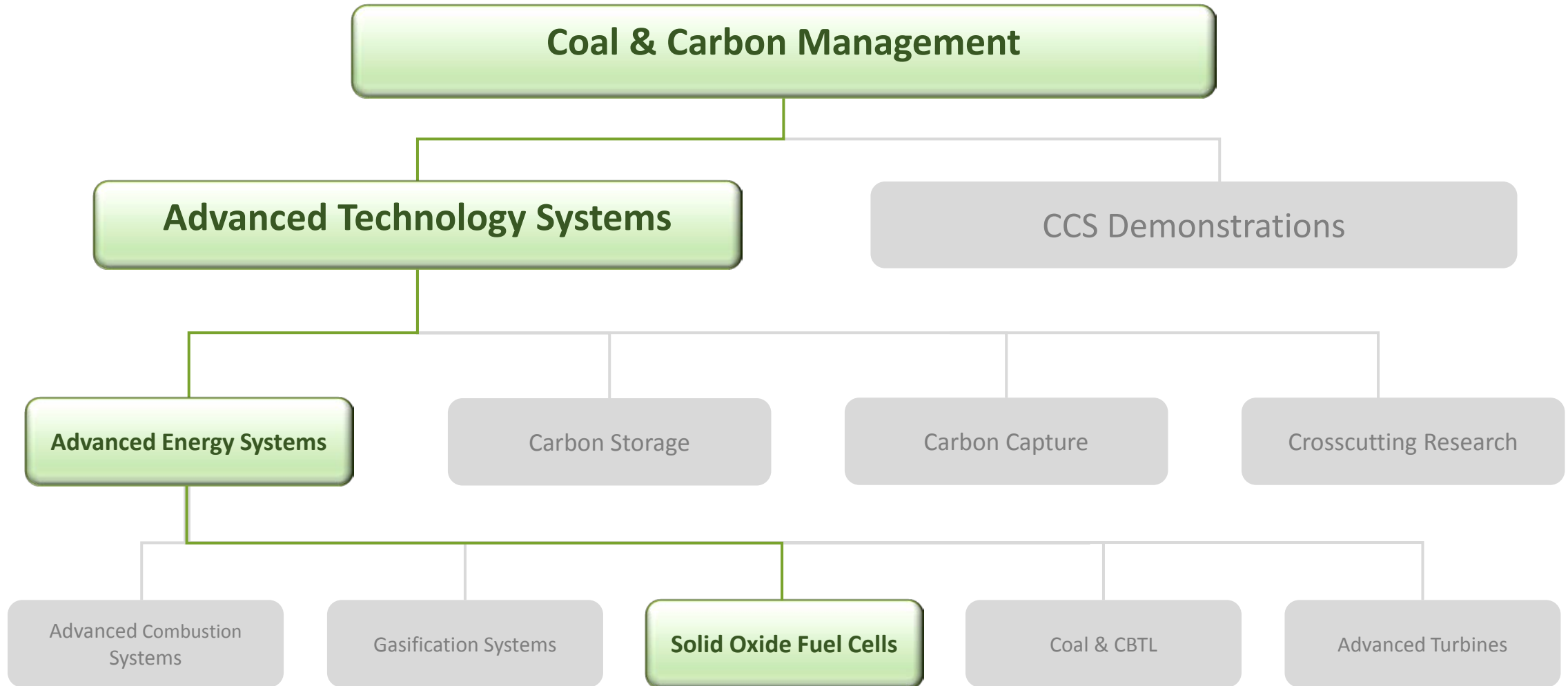


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DOE Office of Fossil Energy (FE)

Solid Oxide Fuel Cell (SOFC) Program



To enable the generation of efficient, low-cost electricity with intrinsic carbon capture capabilities for:

- **Near term: Natural gas-based distributed generation**
 - 100 kWe – 1 MWe
- **Long term: Coal and natural gas utility-scale applications with Carbon Capture and Sequestration (CCS)**
 - 10 MWe – 50 MWe

Based on progressively larger natural gas-fueled validation tests, MWe-class DG SOFC Power Systems that are cost-competitive with existing DG technologies are envisioned circa 2020

SOFC Program Structure

TECHNOLOGY AREA

SOLID OXIDE FUEL CELLS

KEY TECHNOLOGIES

Cell Development

- *R&D on individual cell components*
 - *TRL 2-5*

Core Technology

- *R&D on individual cell components*
 - *TRL 2-5*

Systems Development

- *Systems Integration*
 - *RD&D on entry-into-service systems*
 - *TRL 6-8*
- *Innovative Concepts*
 - *R&D on 2nd generation cells & stacks*
 - *TRL 6-8*

RESEARCH FOCUS

Challenges

- Increase power density
- Lower degradation
- Reduce costs

Approach

- Innovative materials
- Increase cell area
- Automation

Challenges

- Thermal gradients
- Flow maldistribution
- Lower cost

Approach

- Modeling
- Robust/low cost materials
- In-stack fuel reformation

Challenges

- Component integration
- Complexity
- Operating strategy

Approach

- Systems analysis
- Progressively larger system tests
- Multiple demonstrations

Challenges

- Reduce degradation
- Improve reliability
- Lower cost

Approach

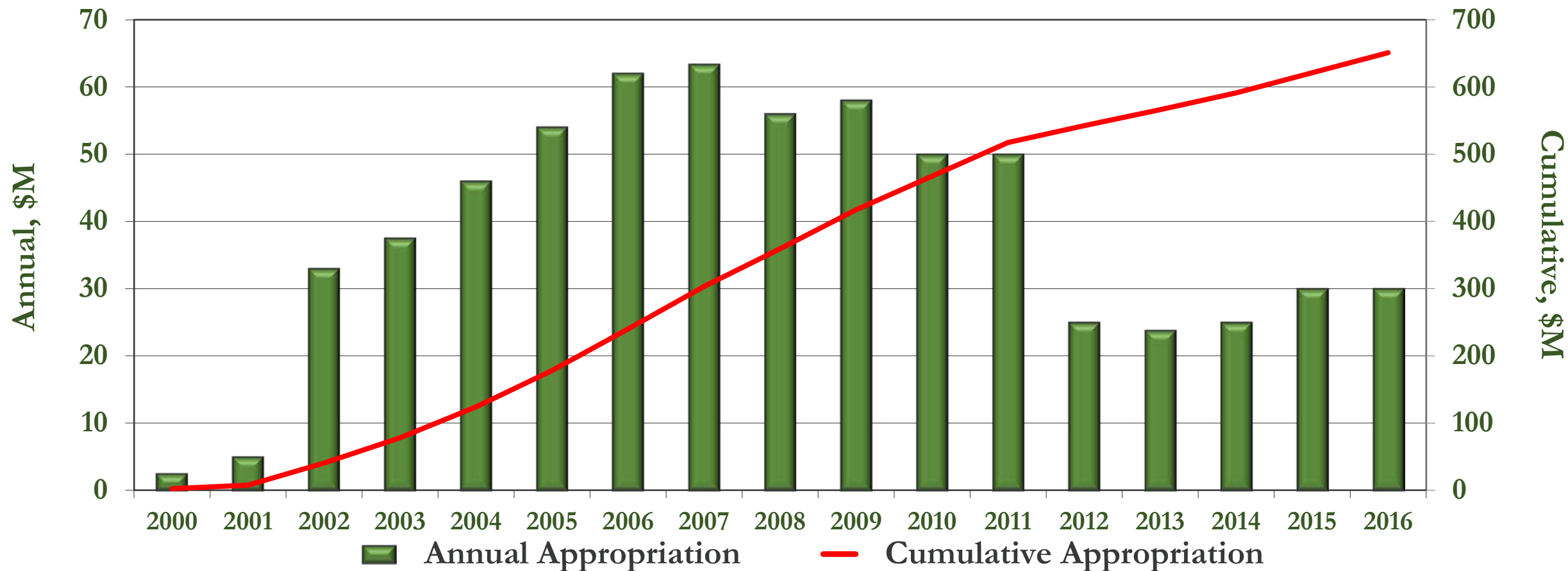
- Modeling
- Compact design
- Advanced manufacturing

SOFC Program

Funding History

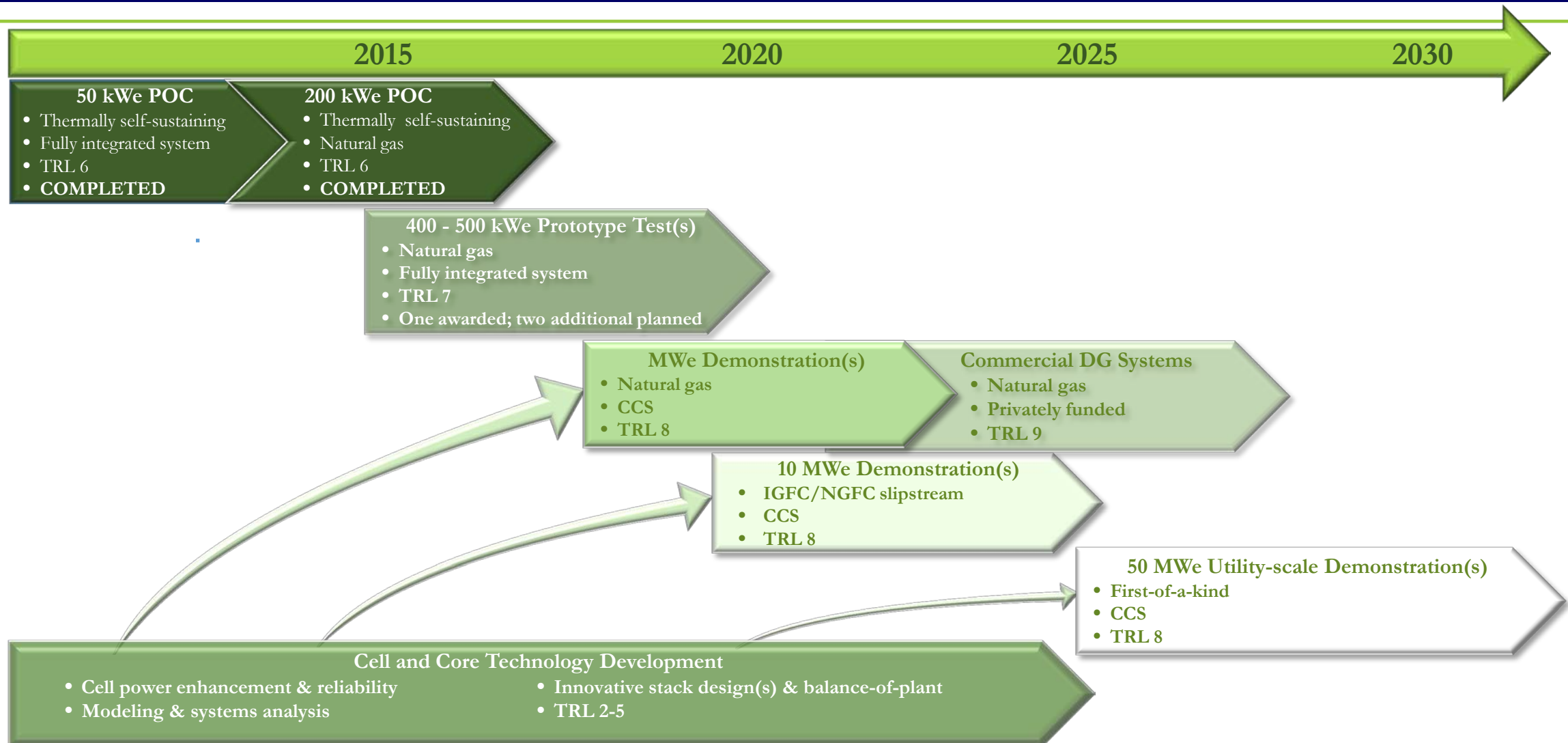
Fossil
Energy

National Energy
Technology Laboratory



SOFC Program

Technology Development Schedule



- Test progressively larger stacks/systems
- Explore new cell and stack concepts to significantly undercut cost targets
- Continue R&D to reduce cost, improve performance, and improve reliability

SOFC Reliability Challenges

Technology	Topic	Issue
Cells	Manufacturing/QC	<ul style="list-style-type: none">• Manufacturing reliability/quality control issues.• Non- destructive tests• Cell –to-cell variability
	Chemical Instability	<ul style="list-style-type: none">• Long-term microstructural/chemical changes in cell• Phase separation
Stacks	Manufacturing/QC	<ul style="list-style-type: none">• Dimensional tolerances
	Contacts	<ul style="list-style-type: none">• Electrode-Interconnect contact variability and degradation
	Seals	<ul style="list-style-type: none">• Seal failure• Corrosion of brazes/welds• Delta T effects
Systems	Electrode Contamination	<ul style="list-style-type: none">• Cathode poisoning (e.g., Cr)
	Anode Redox	<ul style="list-style-type: none">• Anode redox expansion/contraction
	Commissioning	<ul style="list-style-type: none">• BOP components• Thermal management

SOFC Power System

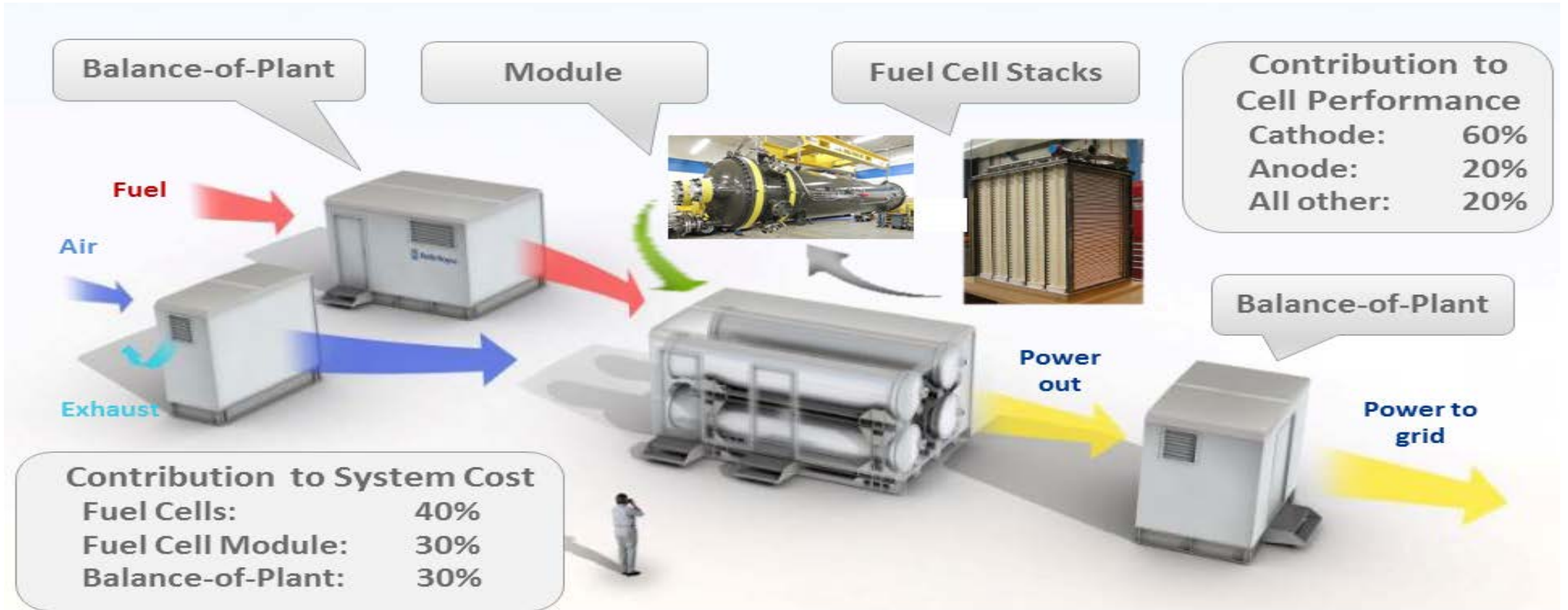


Figure courtesy LG Fuel Cell Systems

➤ **Fuel Treatment**

- Reformer/processor
- Natural gas desulfurization
- Coal contaminants
- Liquid fuels
- Anaerobic digester gas

➤ **Heat Exchangers/Recuperators**

- Low cost
- Compact
- Low pressure drop

➤ **Blowers**

- Fuel (compressor)
- Air

➤ **Issues & Concerns**

- High temperature sensors
- Controls (steady-state and transient)
- Metering devices (steady-state and transient)
- Monitoring devices

➤ **Other**

- First-of-a-kind devices
- Purpose-specific components
- Turbo-machinery
- Anode/cathode poisoning from BOP components
- Insulation