

GM Hydrotec Fuel Cell Technology



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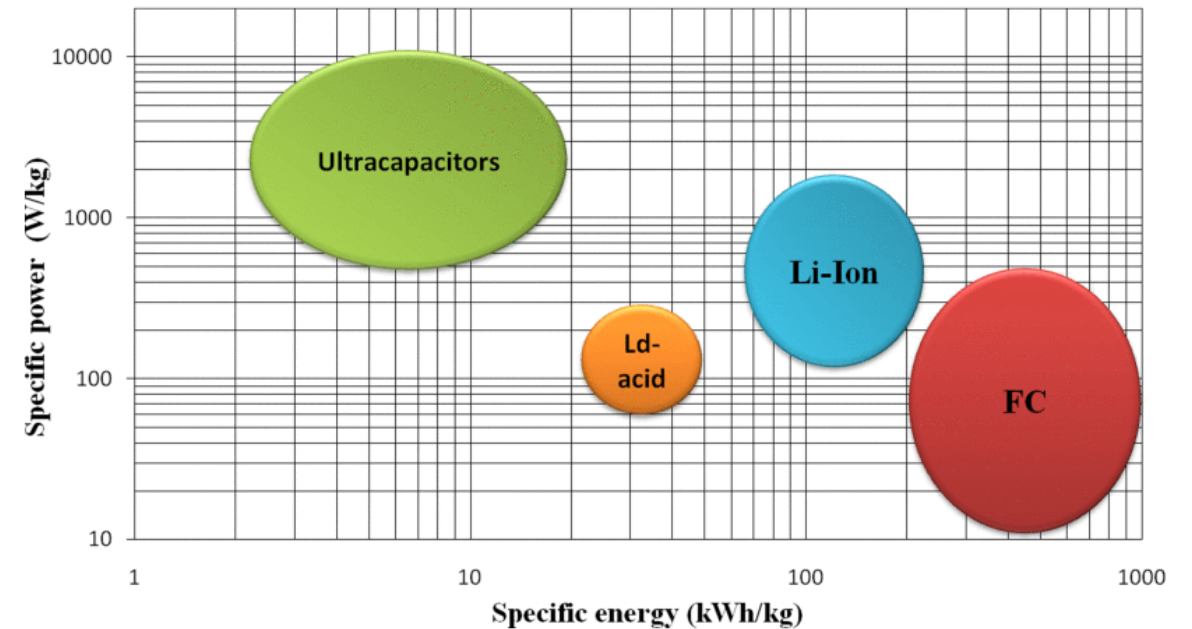


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Why Fuel Cells?

- Higher Energy Density
 - More range than BEVs
- Faster refueling
- Extreme cold weather performance



[2]

[2] J .Snoussi, S. B. Elghali, M. Benbouzid and M. F. Mimouni, "Optimal Sizing of Energy Storage Systems Using Frequency-Separation-Based Energy Management for Fuel Cell Hybrid Electric Vehicles," in *IEEE Transactions on Vehicular Technology*, vol. 67, no. 10, pp. 9337-9346, Oct. 2018, doi: 10.1109/TVT.2018.2863185.



Fuel Cell Development at GM

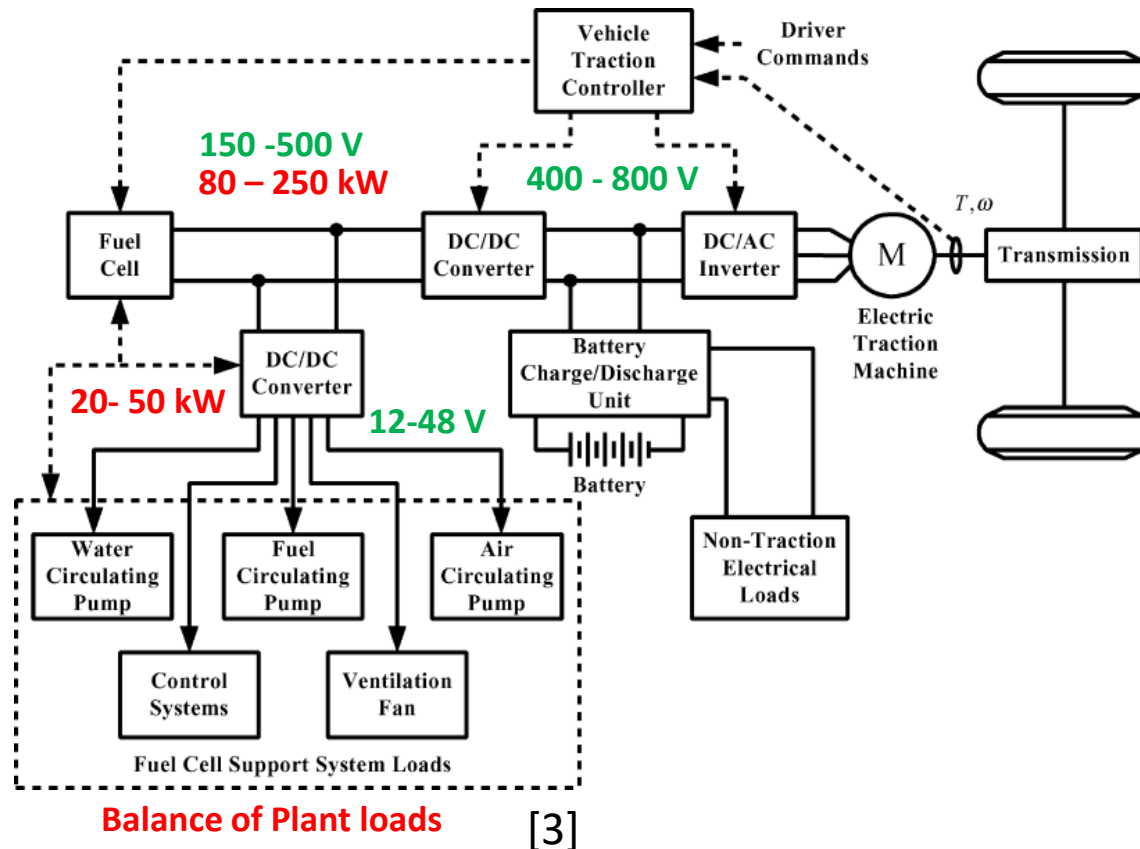
- Fuel Cell type: Proton-Exchange Membrane (PEM) Fuel Cell
- Fuel Cell Stack, materials and systems development
- GM Fuel Cell Power Cubes – 80 kW dc power
- Targeted applications:
 - Medium and heavy-duty trucks (MDHD)
 - Trains



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Fuel Cell Electric Powertrain Architecture



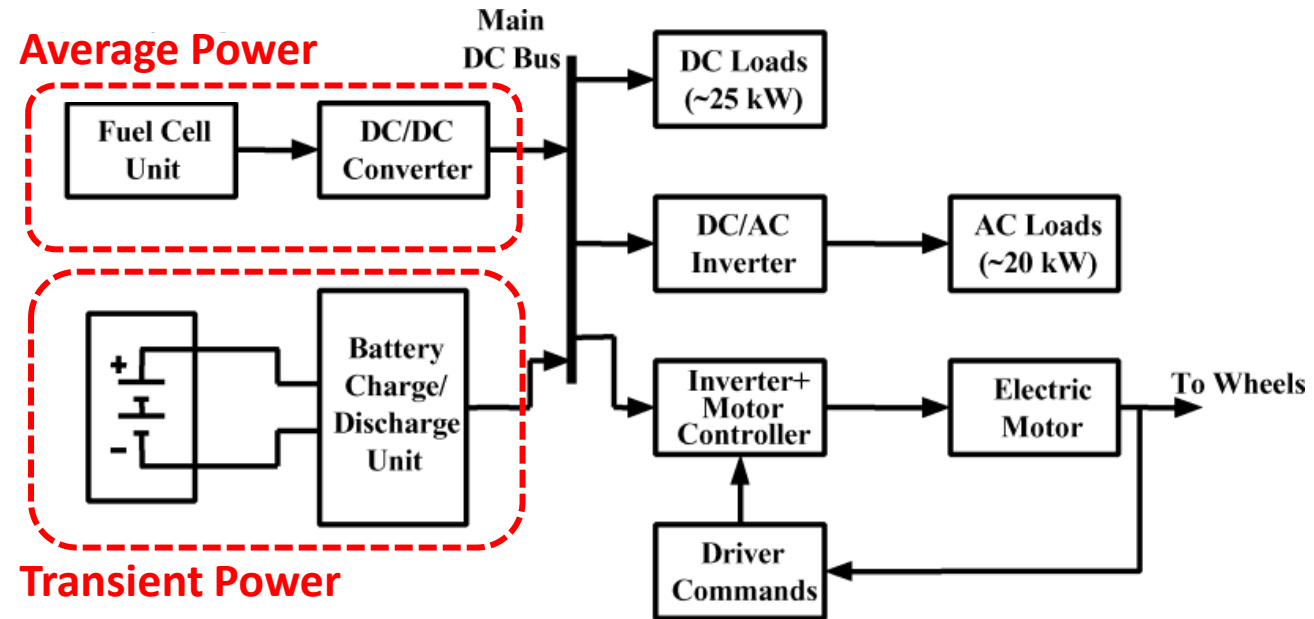
- High Power DC/DC Converter for the fuel cell stack
- DC/DC converter for balance of plant loads

[3] A. Emadi, S. S. Williamson and A. Khaligh, "Power electronics intensive solutions for advanced electric, hybrid electric, and fuel cell vehicular power systems," in *IEEE Transactions on Power Electronics*, vol. 21, no. 3, pp. 567-577, May 2006, doi: 10.1109/TPEL.2006.872378.



Power Electronics for Fuel Cells

- Most efficient, power-dense, and low-cost solution.
- Ripple requirements
 - Input side -- Fuel Cell
 - Output side – HV Bus
- Liquid cooled power electronics



[3]

[3] A. Emadi, S. S. Williamson and A. Khaligh, "Power electronics intensive solutions for advanced electric, hybrid electric, and fuel cell vehicular power systems," in *IEEE Transactions on Power Electronics*, vol. 21, no. 3, pp. 567-577, May 2006, doi: 10.1109/TPEL.2006.872378.



Challenges and Avenues for Improvement

- Wide input voltage range
- High continuous power requirement
- Durability > 5000 hrs and up to 30,000 hrs of operation
- High Temperature --Coolant temperature up to 75 °C
- Managing Transients



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[1] www.gmhydrotec.com

