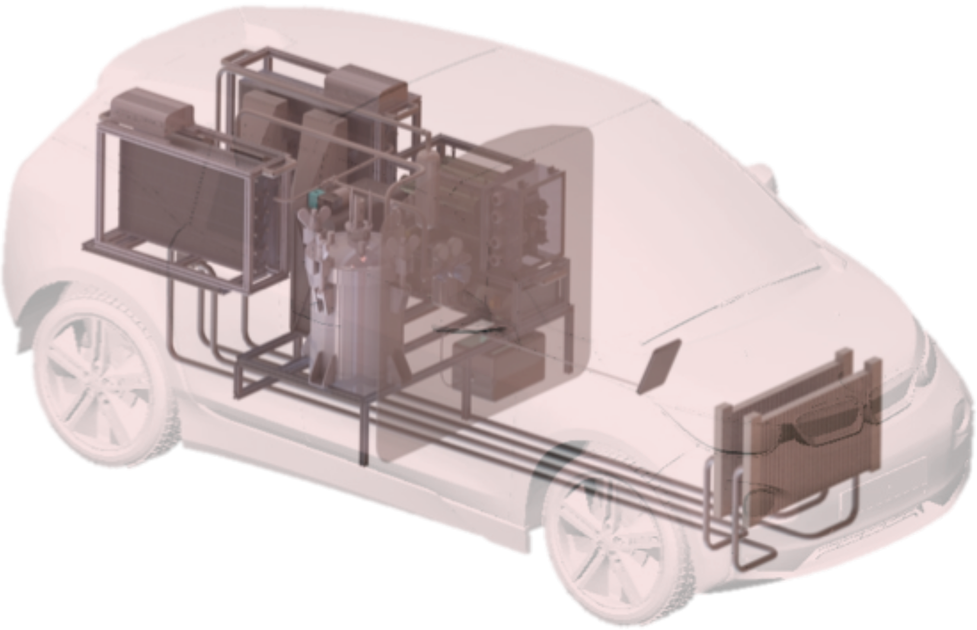
SINDRI Electric Vehicle

Design Presentation

December 7, 2017

MIT | 2.733



Member, Member, Member
Member, Member, Member,
Member

Sponsor at the top, simple visual introduction to the system/topic. This graphic will be used throughout to tie things back together. Clean design with a theme color and consistent use of grayscale for directing audience focus.

Motivation

High Energy Density
- Double that of diesel

Ease of Storage
- A solid block or pellets

Clean Reaction
- Produces usable byproducts

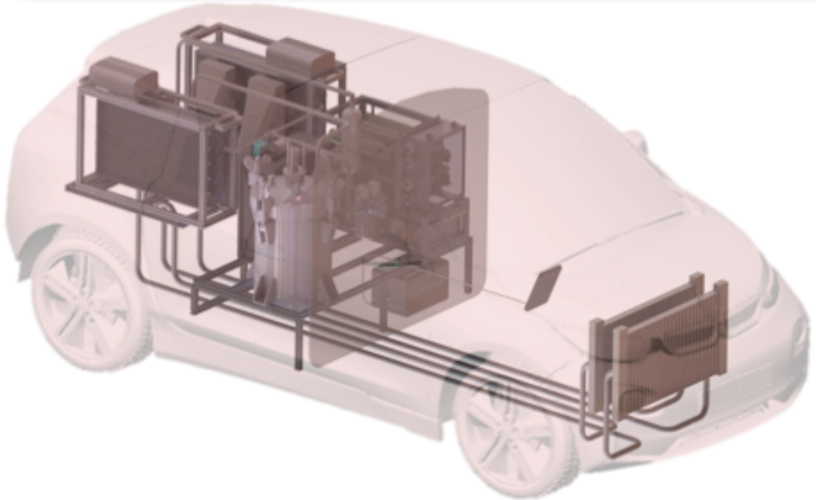
Item	Aluminum	Pressurized H_2	Gasoline	Lithium-ion Batteries
High Energy Density	✓	✓	✓	
Ease of Storage	✓		✓	✓
Clean	✓	✓		✓

Motivation is next slide with high-contrast colors. Note use of green checks to clearly indicate positive aspects that pop immediately. Although Slide is a bit busy.

Goal

1. Build 10 kW BMW i3

2. Demonstration trip to D.C.



Simple and clear project goals that will be easy to tie back to later in the presentation.

Strategy

Aluminum-Water Reaction

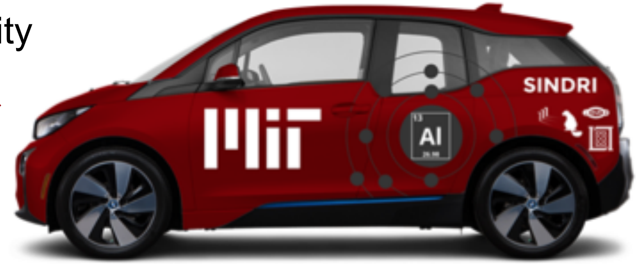
Hydrogen Fuel Cells

BMW i3 Battery

Aluminum →

H_2 →

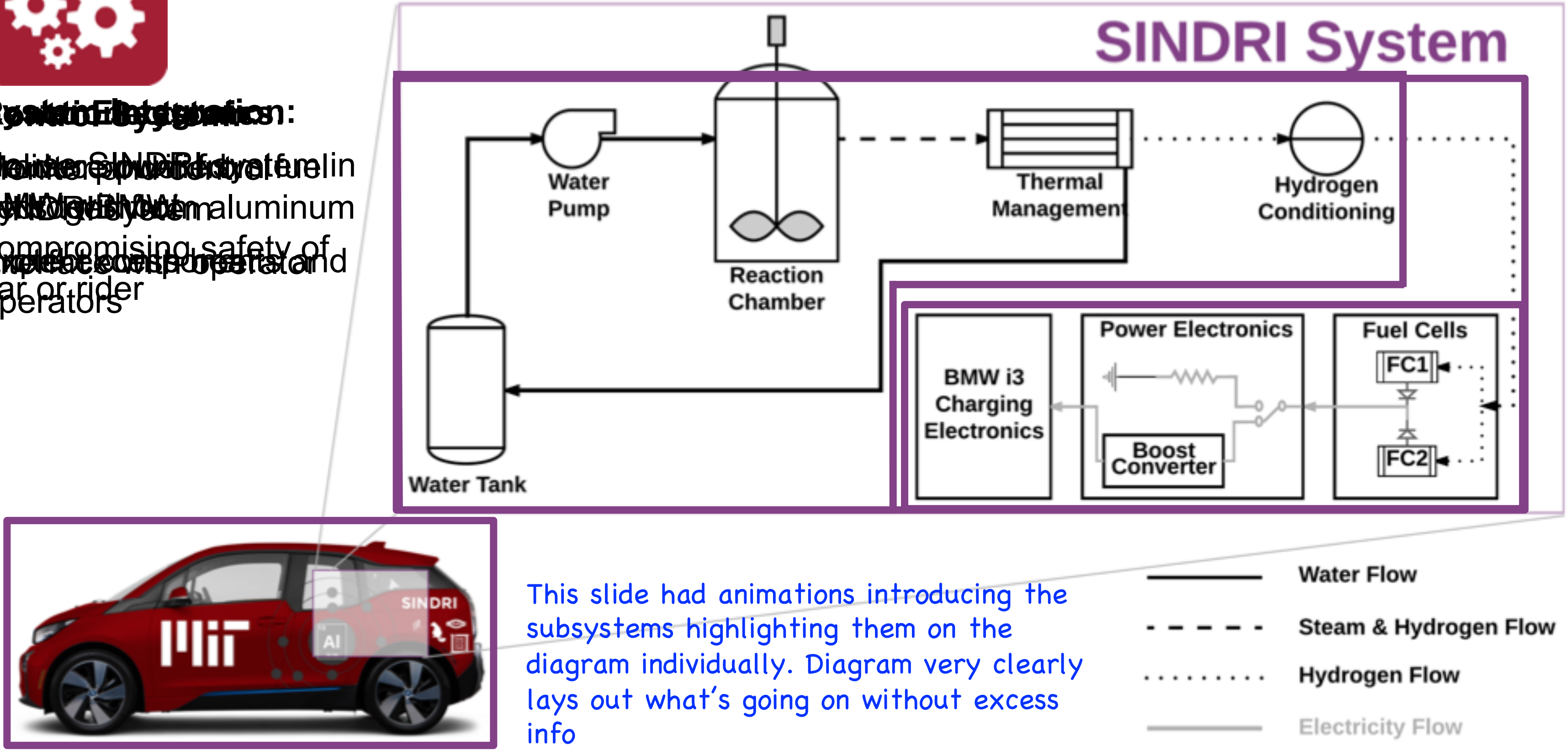
Electricity →



A simple, visual high-level system overview/roadmap. This can be referenced intermediately to keep the audience on track of where they've just been and where they're going.

System Overview

aluminum
compromising safety of
car or rider
operators



This slide had animations introducing the subsystems highlighting them on the diagram individually. Diagram very clearly lays out what's going on without excess info

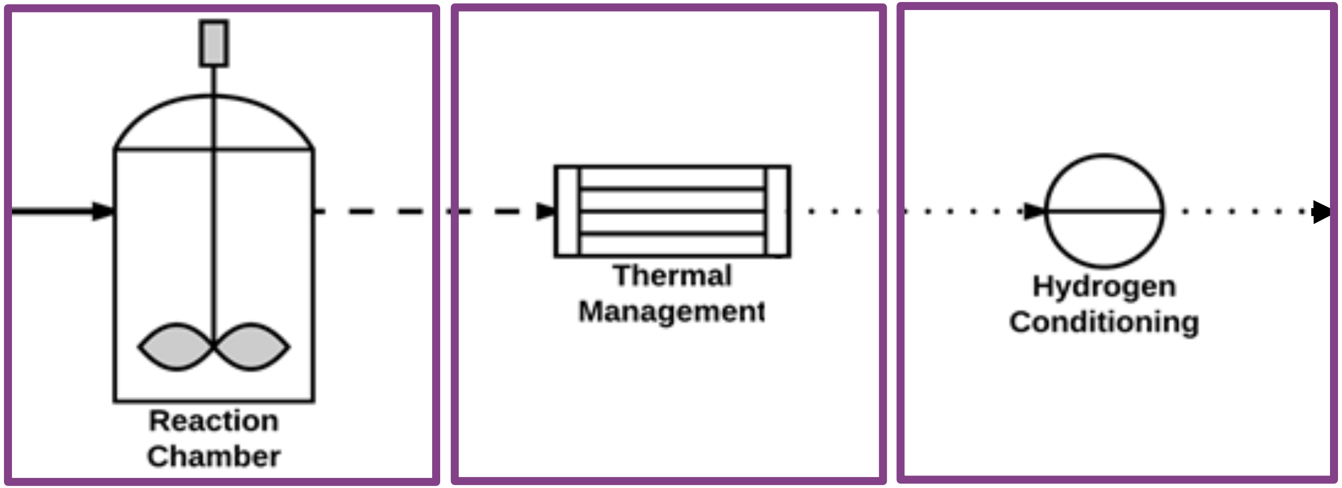
Reaction System Requirements

Reaction Chamber: Produce reliable 120 slpm H_2

Thermal Management: Dissipate 28 kW, recycle condensate, cool H_2 to below 45C

Hydrogen Conditioning: Purify Hydrogen to 99.99% pure H_2

Good use of simple keywords and linking the requirement phrases to subsystem diagrams with high-level flow.



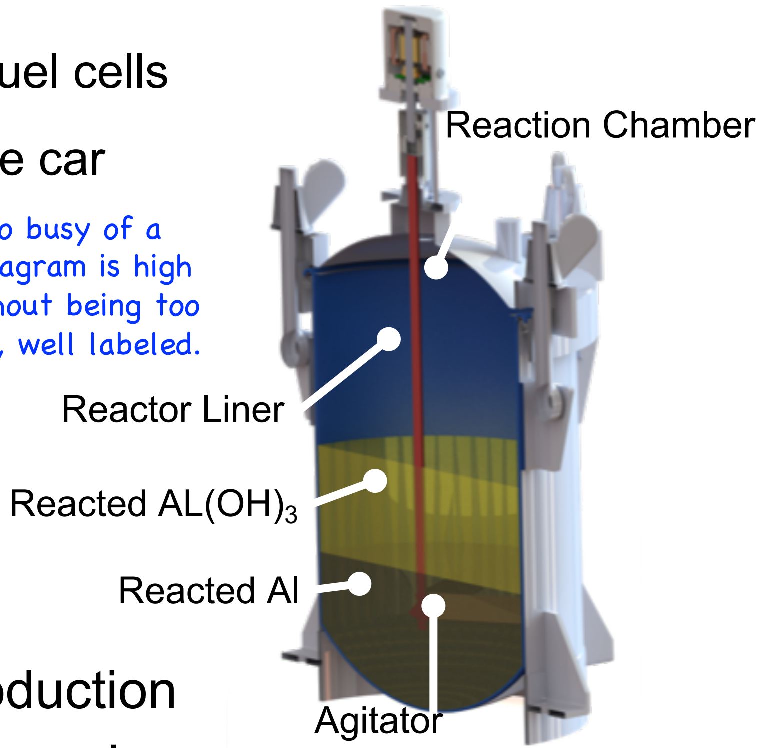
Reactor System

Reaction: Continuously produce hydrogen for the fuel cells

Waste removal: Liner provides easy refueling of the car

Hydrogen Production Rate	120 sL min^{-1}
Production Time	2 Hours
Reactor Volume	32 L
Reaction Temperature	120 ºC
Reaction Pressure	1 barg

Probably too busy of a slide, but diagram is high fidelity without being too complicated, well labeled.



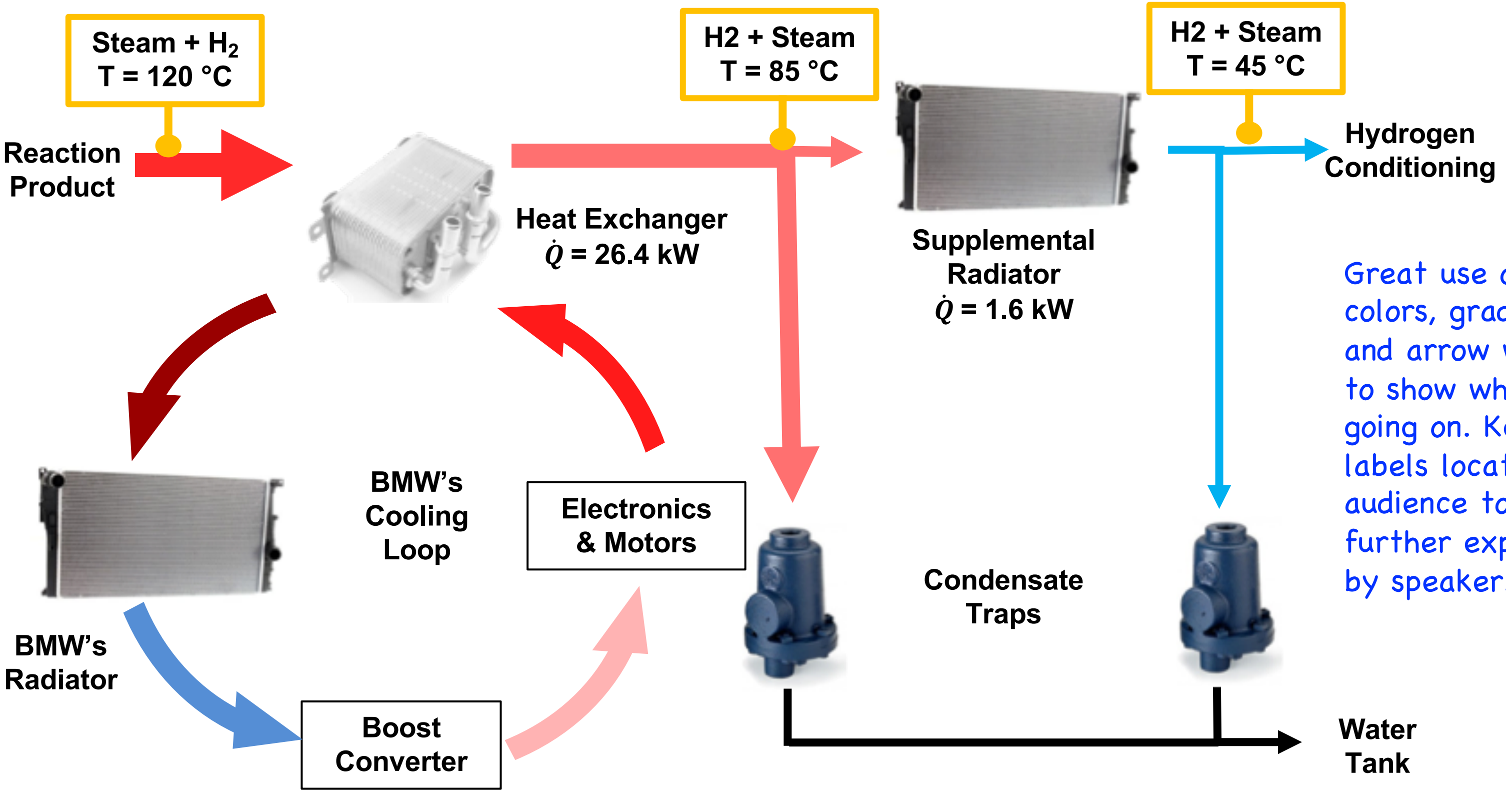
Aluminum Fuel

- 13.4 kg of aluminum
- 23 kg of water

Hydrogen Production

- 0.7 kg H_2 per hour
- 33.4 kg of $Al\,(OH)_3$

Thermal Management



Great use of colors, gradients, and arrow widths to show what's going on. Key node labels locate the audience to further expansion by speaker.

Hydrogen Conditioning

Oxygen Scrubber: Removes O_2 previously dissolved in water down to <5 ppm

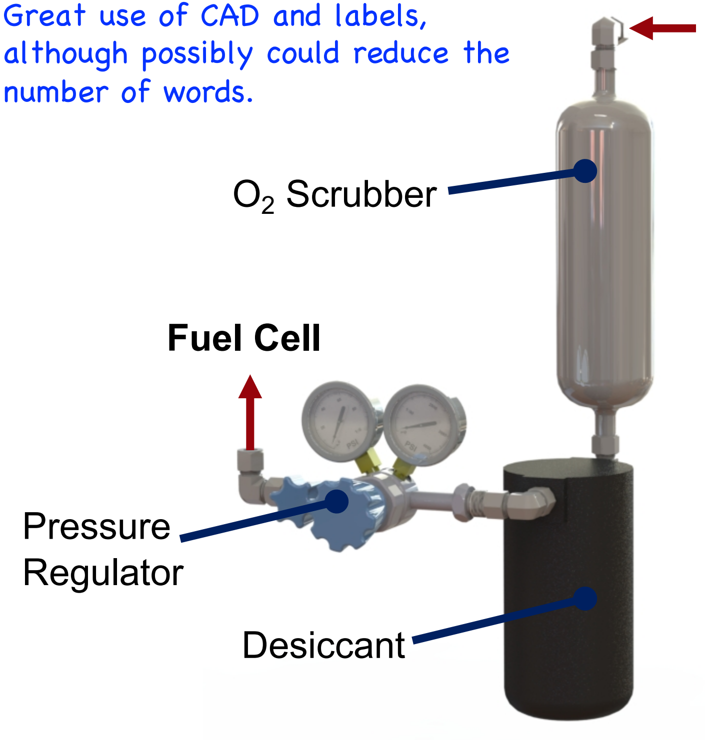
Desiccant: Removes residual water vapor to dew point of -40 °C

Pressure Regulator: Provides fuel cell intake pressure of 0.55 barg

White-space separation between primary functions above and secondary features/operation below

System Priming: Upon initial setup, system will be vacuumed of air, and pre-filled with H_2

Great use of CAD and labels, although possibly could reduce the number of words.

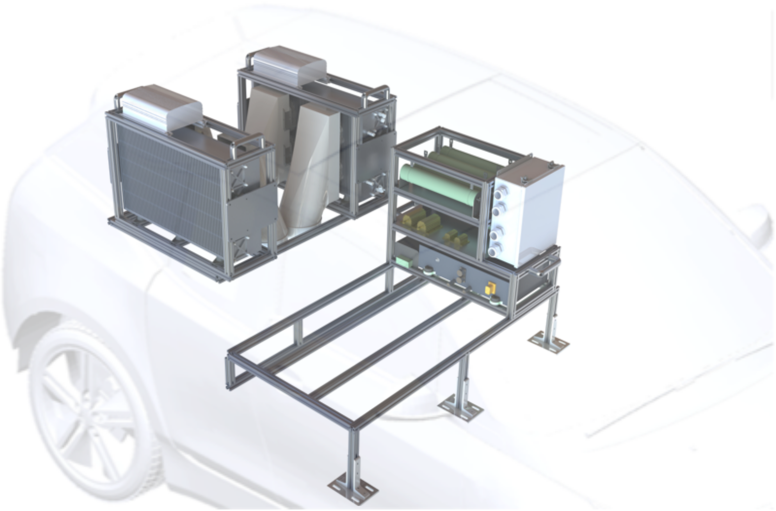


Power Electronics Requirements

High Current: Supply currents of up to 140 amps to the boost converter

Variable Load: Adjust the load to ramp the fuel cells to full power

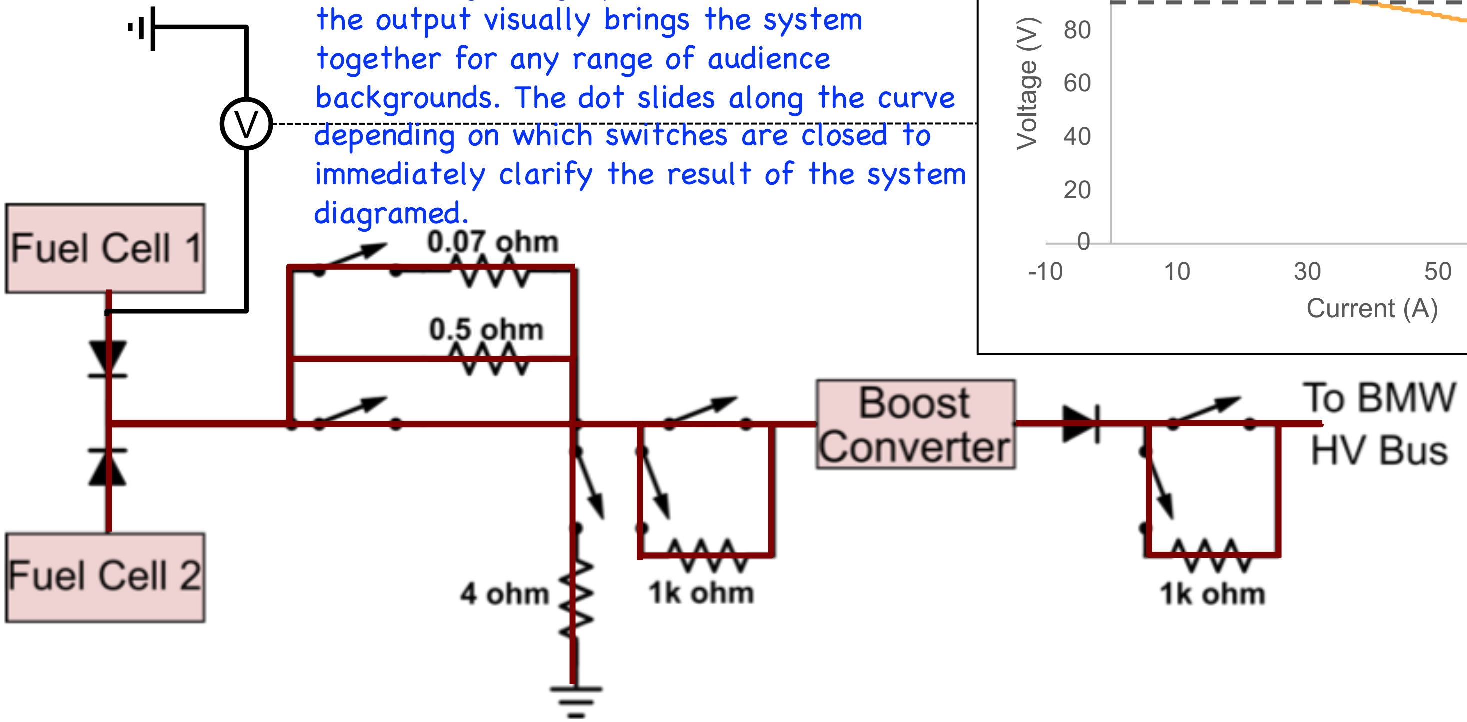
Supply: Deliver 10kW of power to the BMW battery

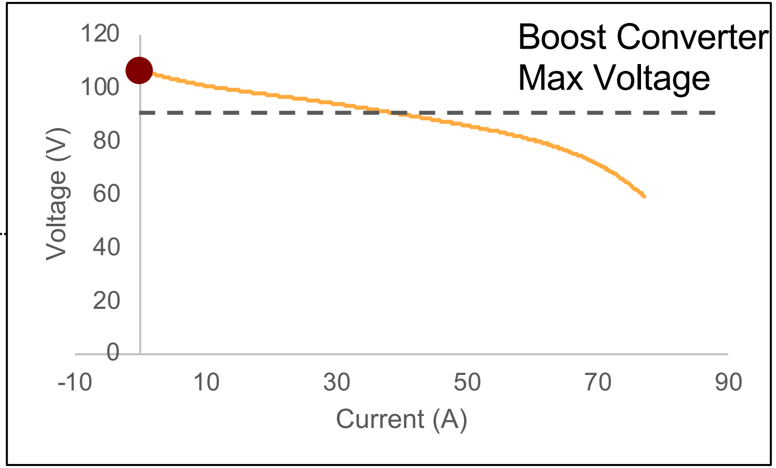


Strength of a well-thought out high-fidelity but simplified diagram makes it easy for the speaker to add details and relate them to the overall system.

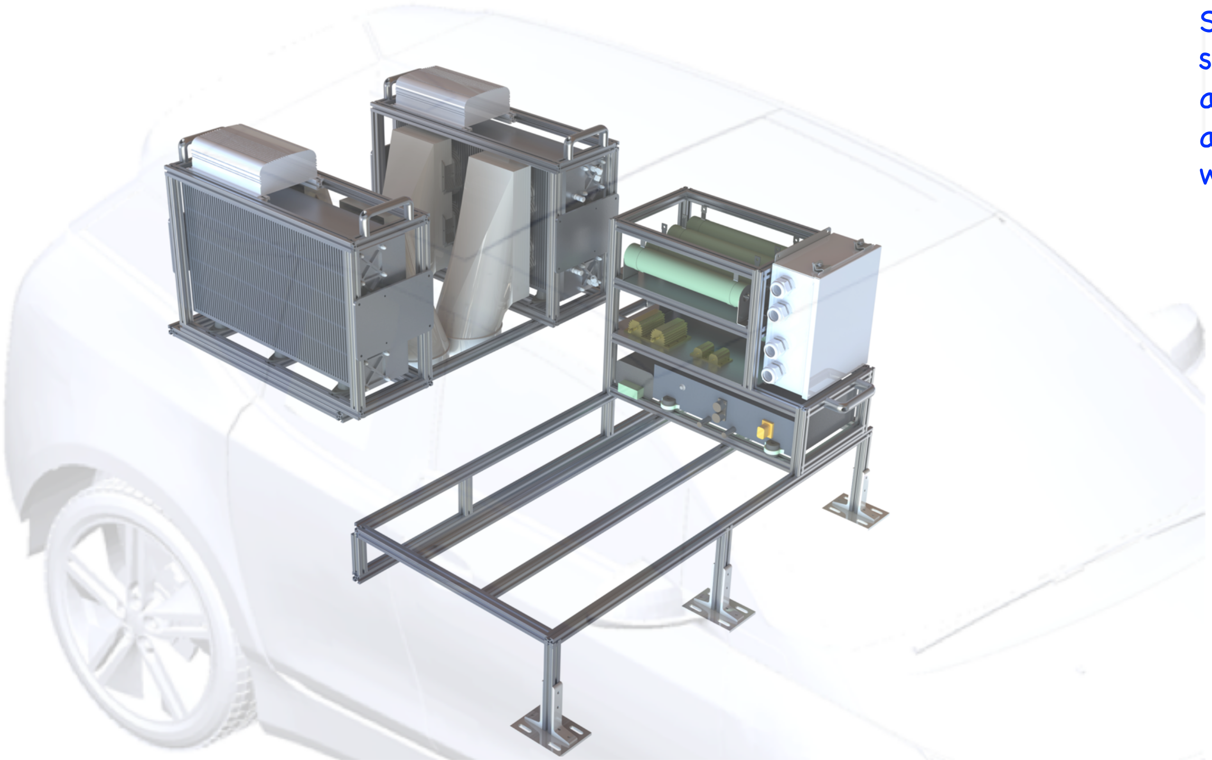
Ramp Circuit Design

Introducing the graph of the behavior at the output visually brings the system together for any range of audience backgrounds. The dot slides along the curve depending on which switches are closed to immediately clarify the result of the system diagramed.



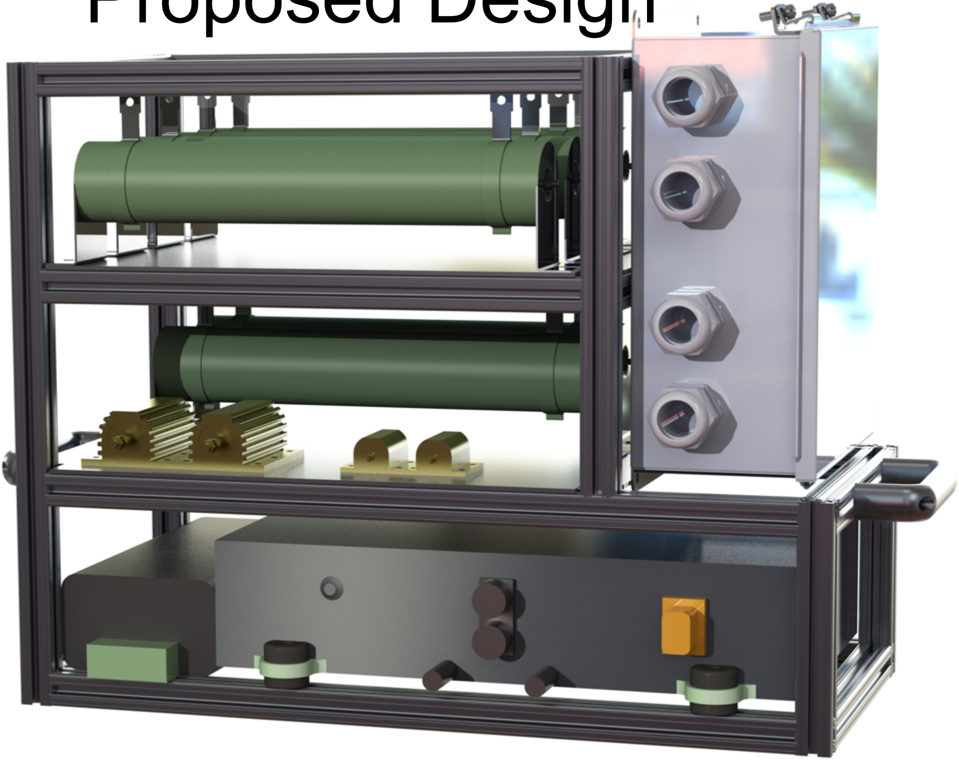


Proposed Design



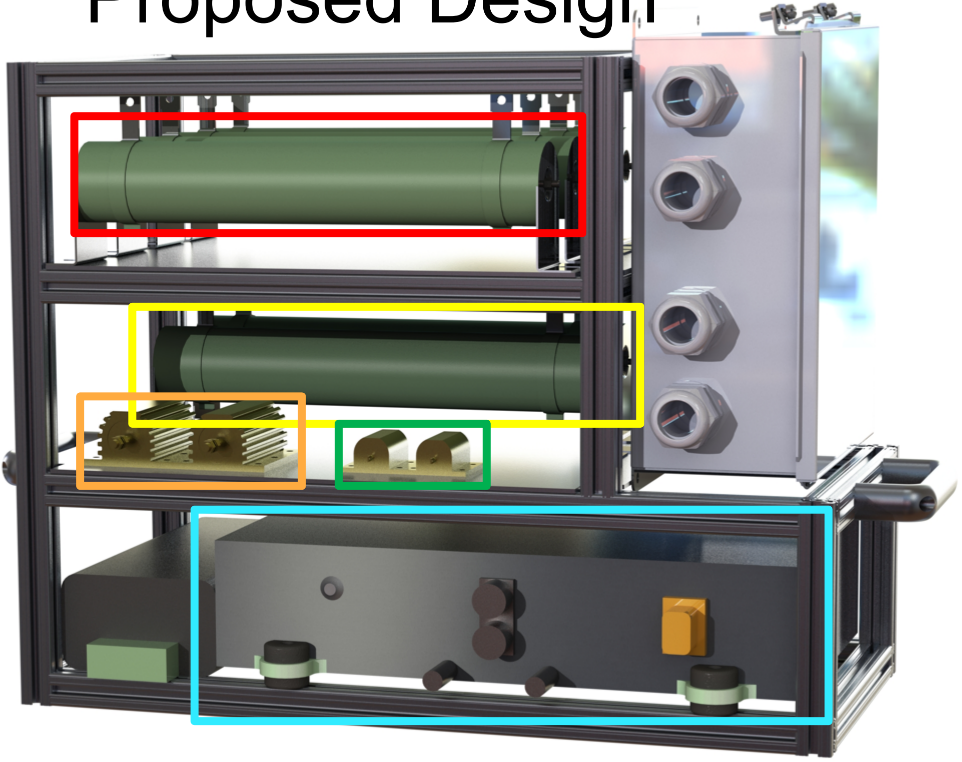
Setting up a subsystem which the audience will not have as much background with.

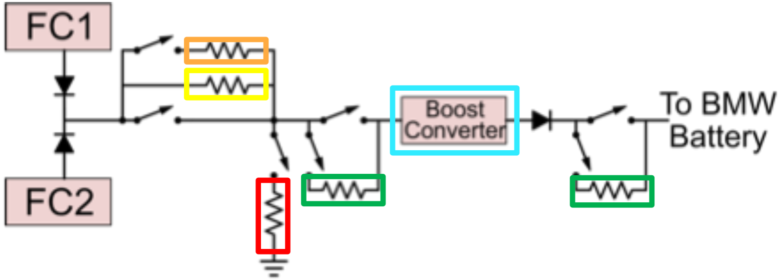
Proposed Design



Use realistic but contrasting colors to help components stand out

Proposed Design





Animations are on this slide and previous slide to help the presenter walk through the components, introducing them one at a time to build the complete picture. Added white space keeps the audience from being overwhelmed with words or other details. Note no wires, "trivial" components to the diagram for the bare purpose of the slide.

Control System

Monitor: Sensors placed throughout SINDRI system to track crucial parameters

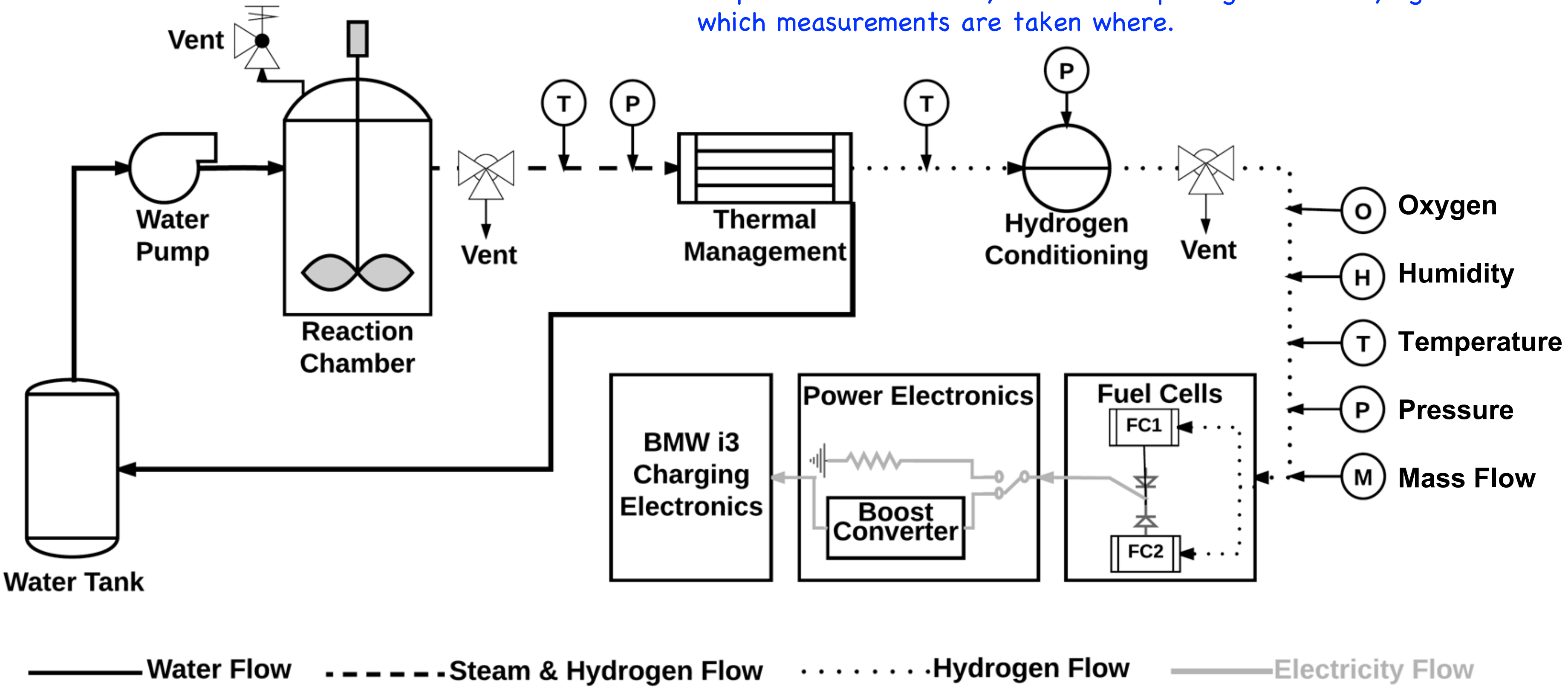
Control: Sensor data is then used to automatically control the system and activate emergency procedures when required

Interface: Provide display and interface for the operator

Good use of white space keeps the reader focused and doesn't pull them from what the presenter is saying.

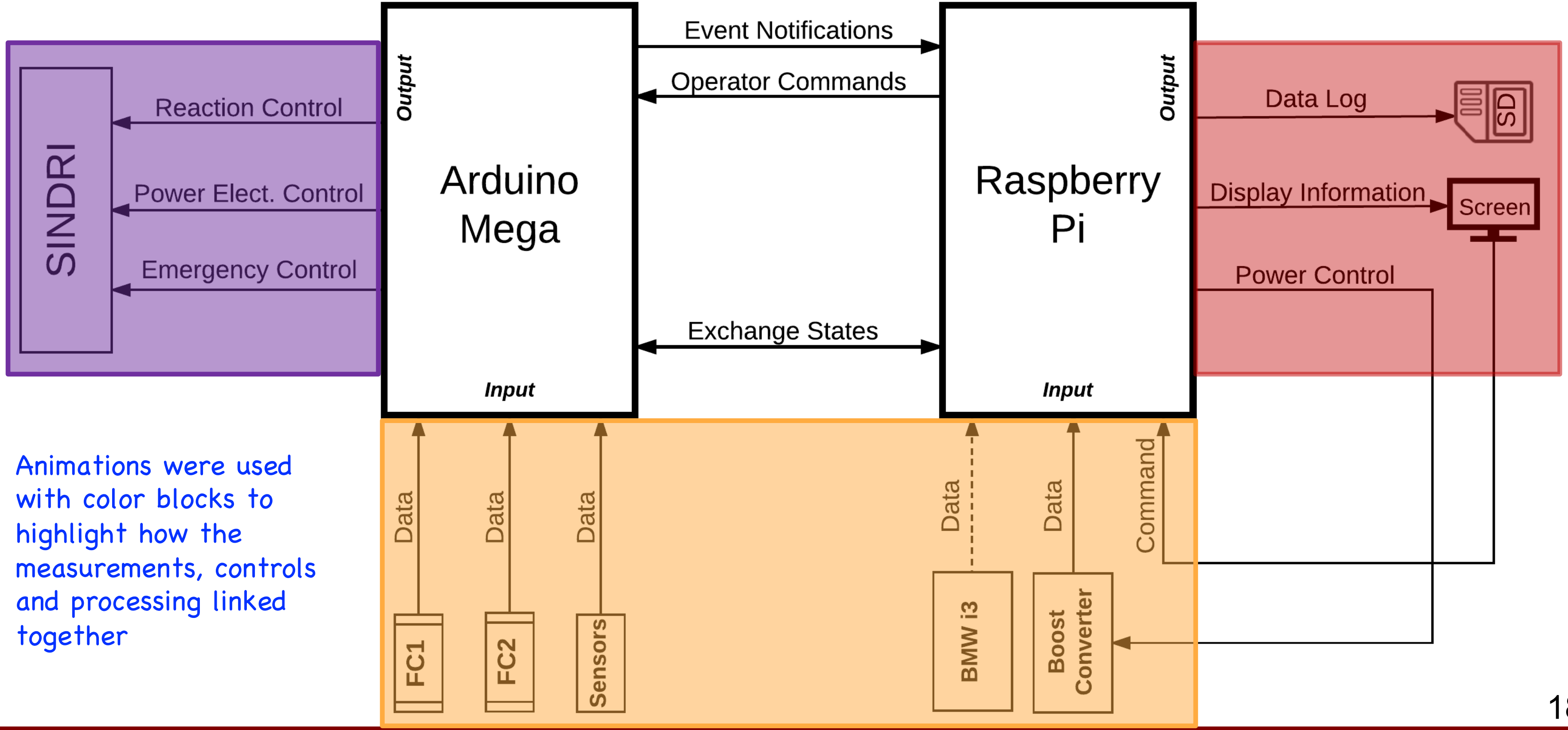
Control System

Helpful return to the system roadmap/diagram identifying which measurements are taken where.



Control System

Implement feedback loops for automated control of system



Animations were used with color blocks to highlight how the measurements, controls and processing linked together

System Integration

RX Reaction Chamber

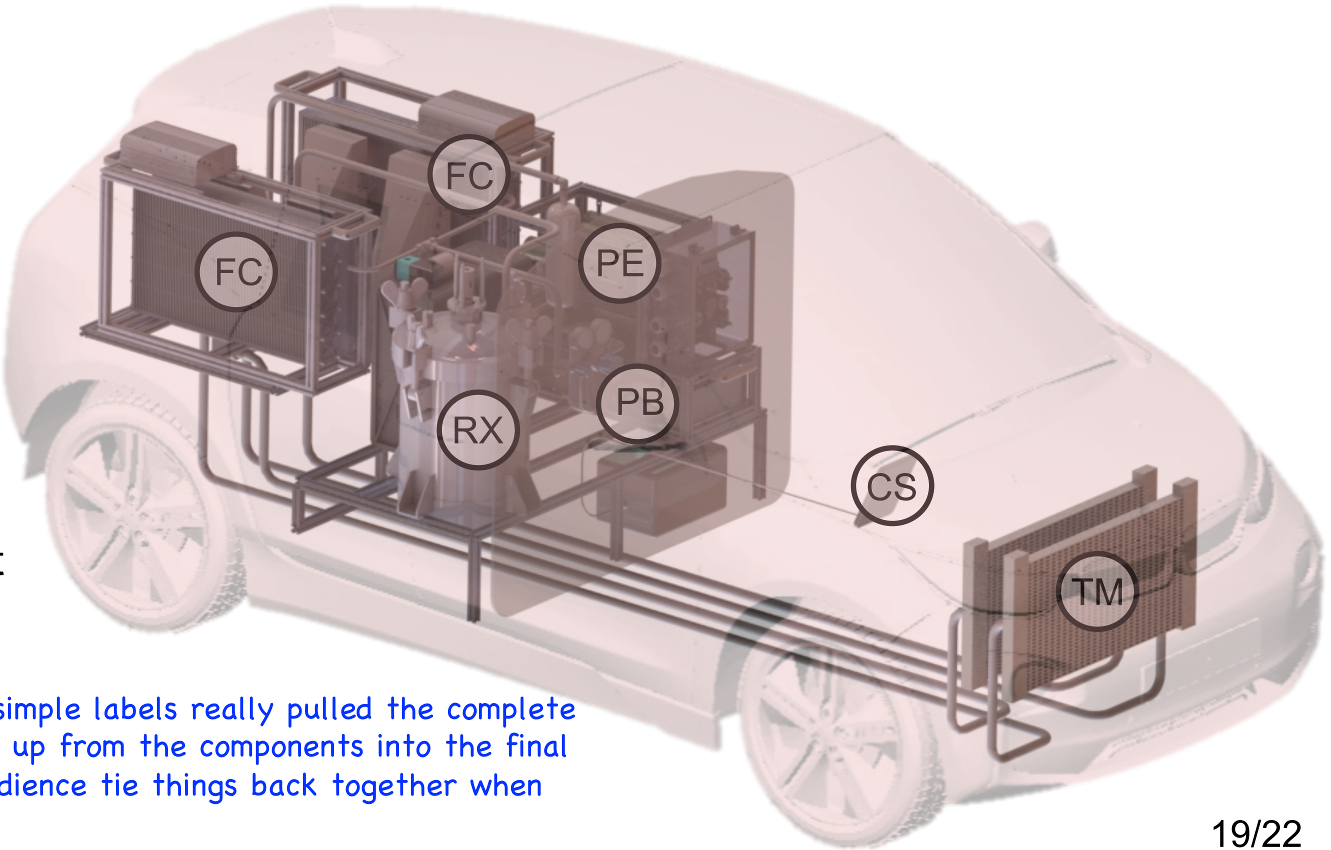
FC Fuel Cells

PE Power Electronics

CS Control System

TM Thermal Management

PB Polycarbonate barrier



Use of animation, CAD and simple labels really pulled the complete system together, building it up from the components into the final overall system. Help the audience tie things back together when zooming out.

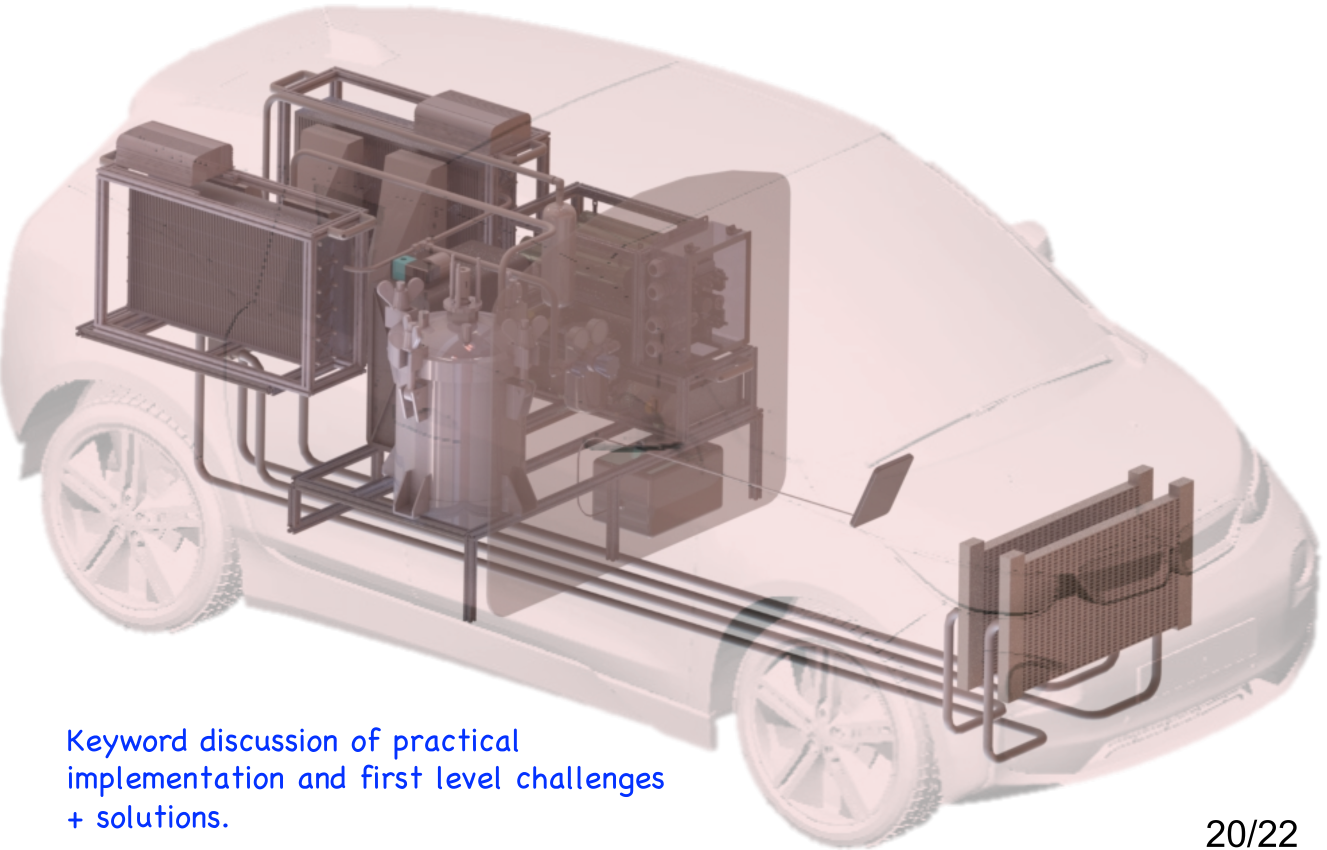
System Integration

Modular: 80/20 frame connected to hard points to allow for simple adjustments

Easy: Access to critical components

Safe: Polycarbonate barrier separates driver from SINDRI system

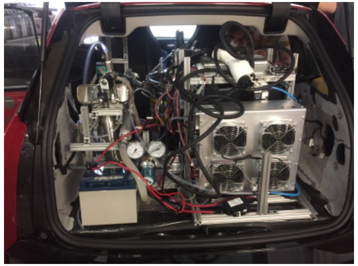
Cool: Fuel cell exhaust heat vented to wheel well

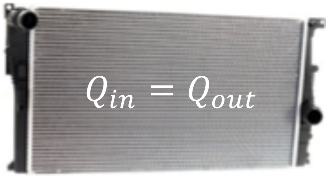


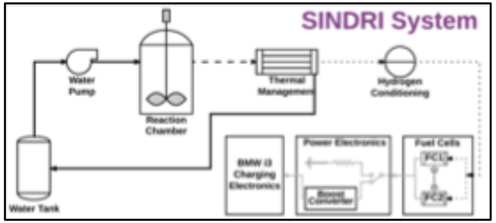
Keyword discussion of practical implementation and first level challenges + solutions.

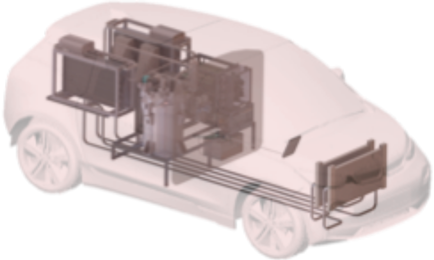
Contributions and Next Steps

September 2017	Starting point
October 2017	System Analysis
December 2017	System Design
February 2018	Subsystem Development
April 2018	System Assembly
Summer 2018	Drive to DC









Animations used to link the graphics with timeline, but the graphics may be a bit small and busy.

Thanks to the Group


Member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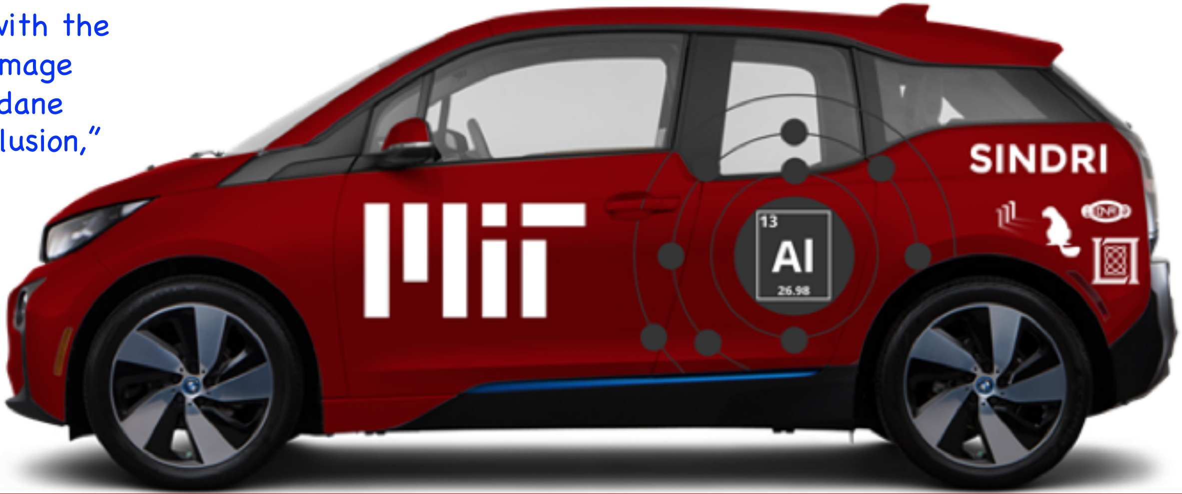
Great conclusion this and next slide to end with the full team/system image rather than a mundane "thank you," "conclusion," or "the end" slide.




MCMXVI
MASSACHVSETTS INSTITVTE OF TECHNOLOGY
SINDRI
ALUMINUM ELECTRIC VEHICLE
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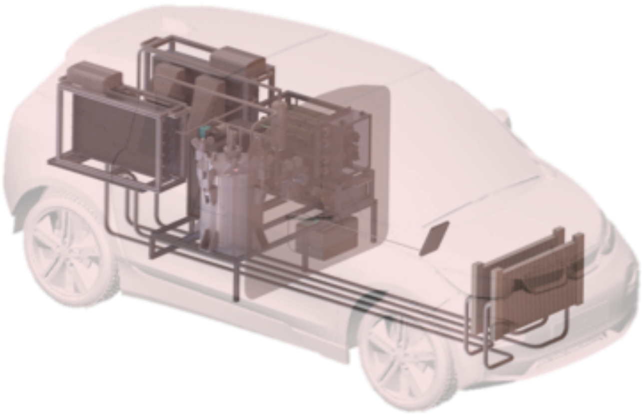
Backup Slides

Always good to have for anticipated questions.

System Integration

Item	Mass (kg) (395 Max)	Volume (L) (1800 Max)	Power Req'd (W)
Reaction System	65	101	67
Control System	<15	<20	77
Power Electronics	40	90	51
Fuel Cells	60	48	576
Polycarbonate Barrier	55	42	0
Overhead	50	602	116
Total	**285**	**903**	**887**



Risk Analysis

1) Insufficient cooling of hydrogen
2) Fuel cell poisoning
3) Hydrogen leaks
4) Fuel cell overload
5) Loss of control power
6) Mechanical failure of system integration
7) BMW overvoltage
8) Insufficient hydrogen production
9) Insufficient fuel cell cooling

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Rare				7	
Unlikely		4 6	2		
Moderate	8	5 9	1		
Likely		3			
Near Certain					