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3.7 Reduction of CO₂ Emissions Through Lightweight Body Panels

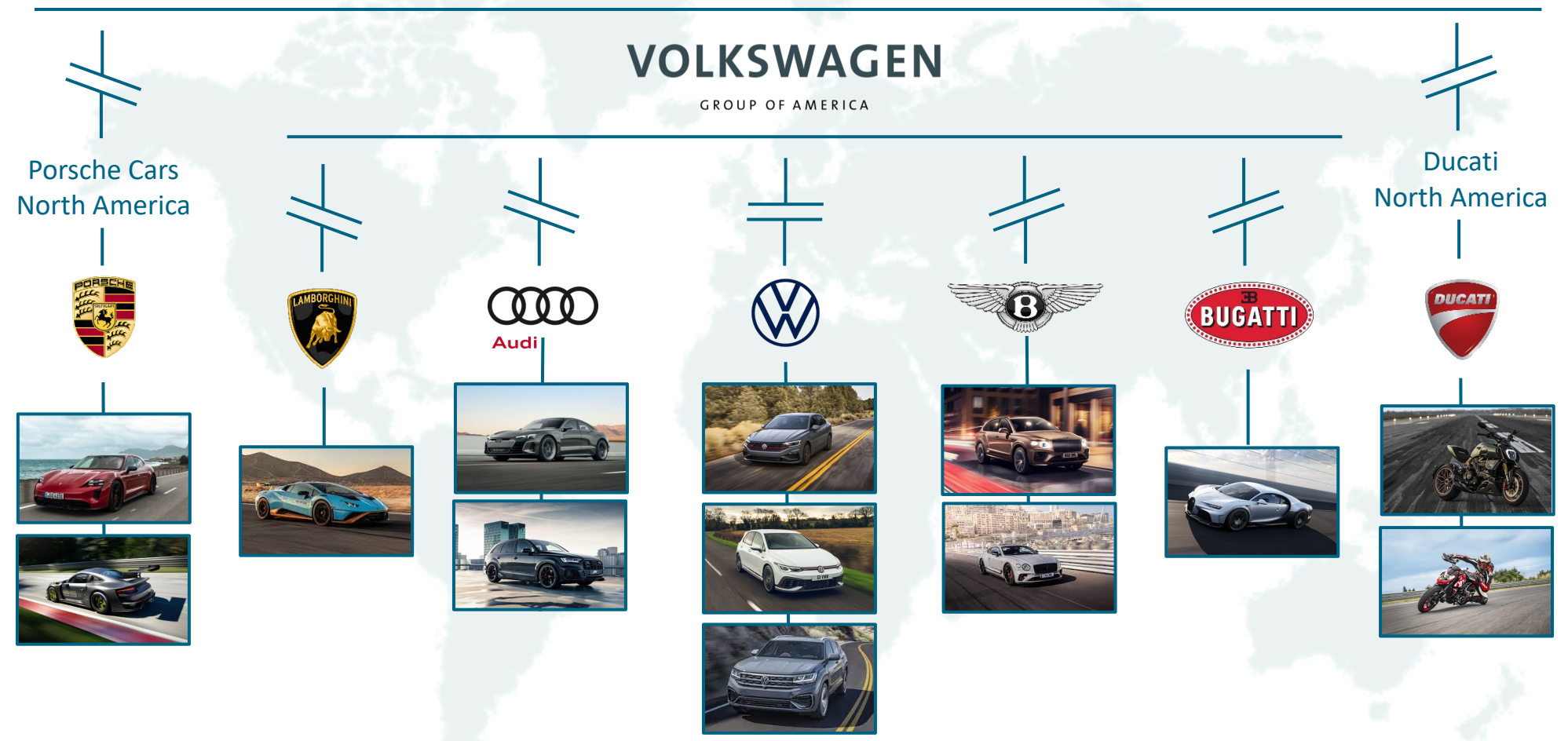
June 15th, 2023 / Innovation Hub Knoxville

Classification: PUBLIC

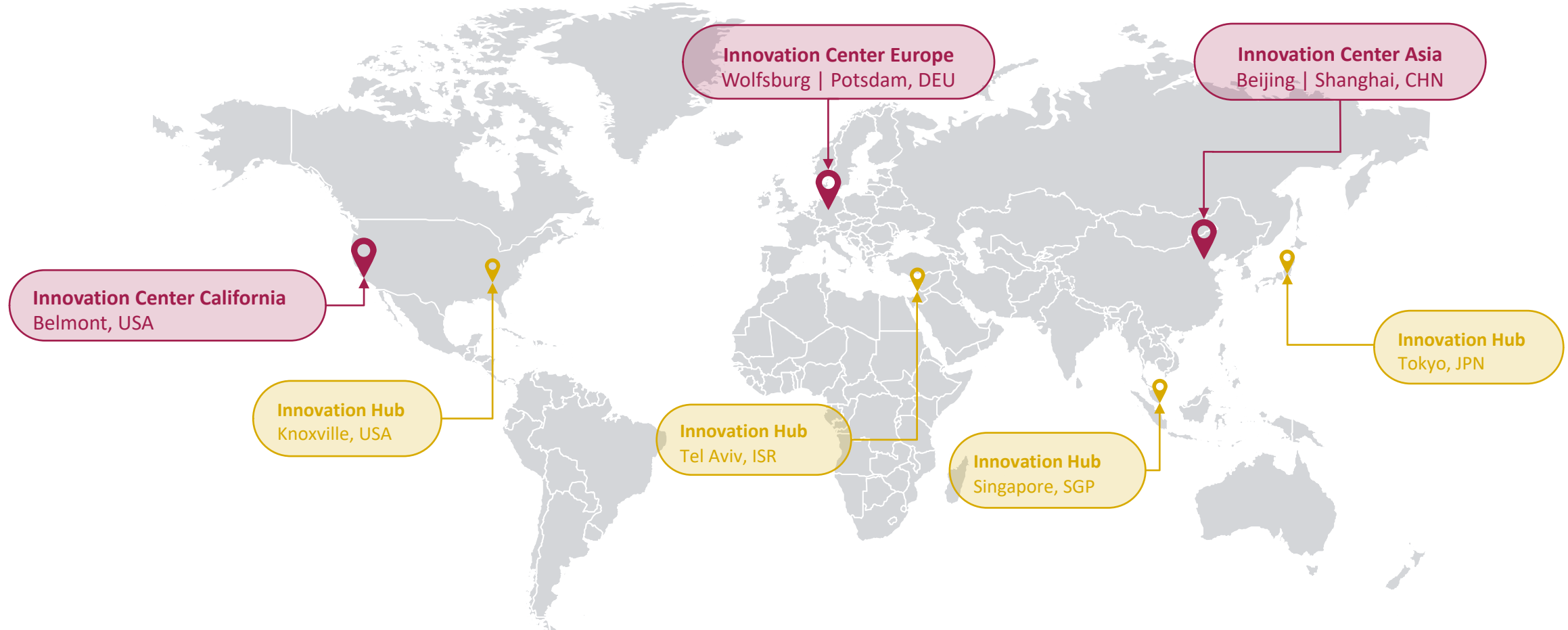
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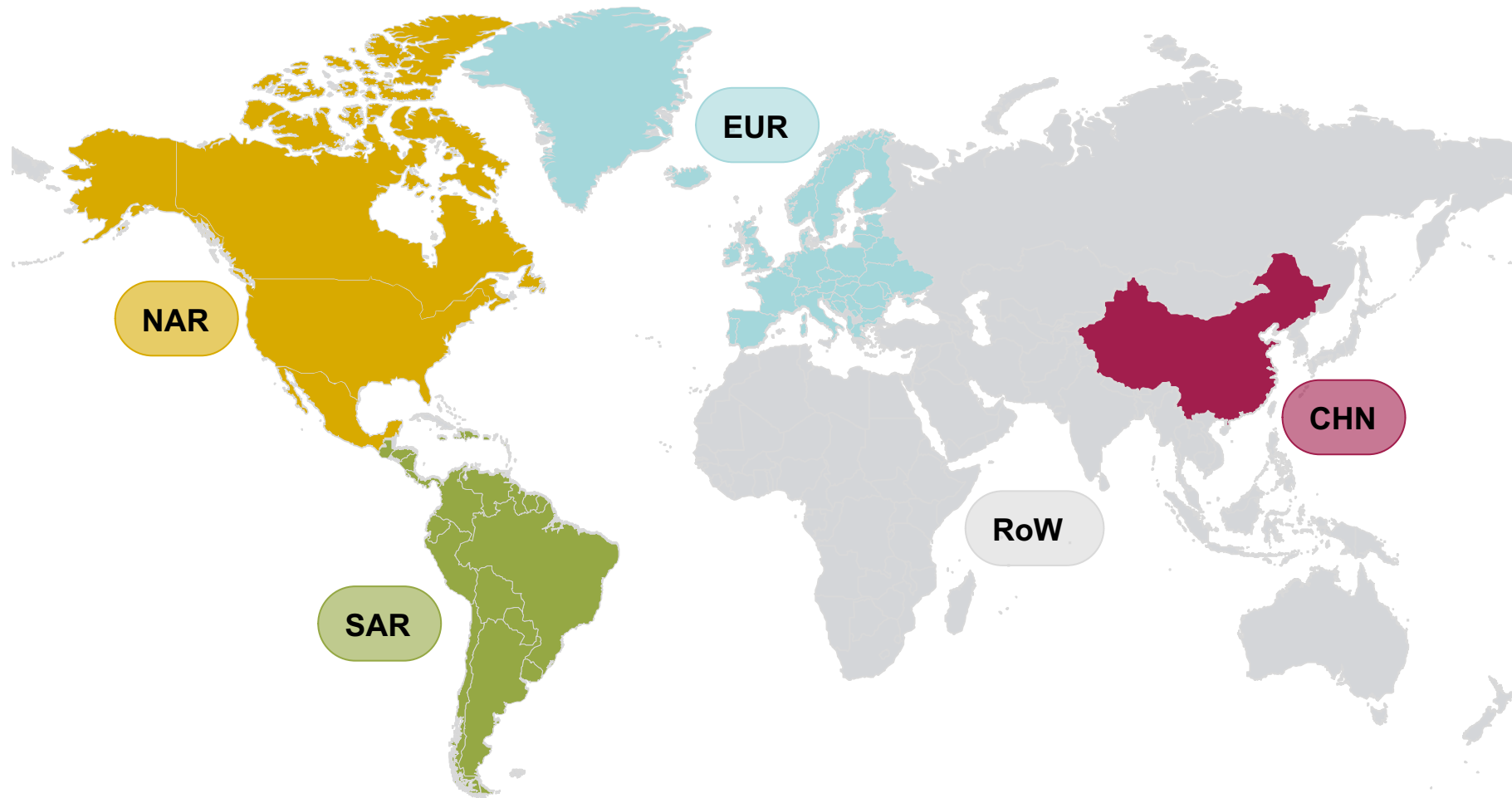
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Volkswagen Group International Innovation Ecosystem



Volkswagen Global Regions



Engineering in the North American Region



Field of Actions and Lighthouses of Group Innovation

Sustainability

GO.SUB-ZERO

Beyond carbon-neutral mobility

Circular Economy

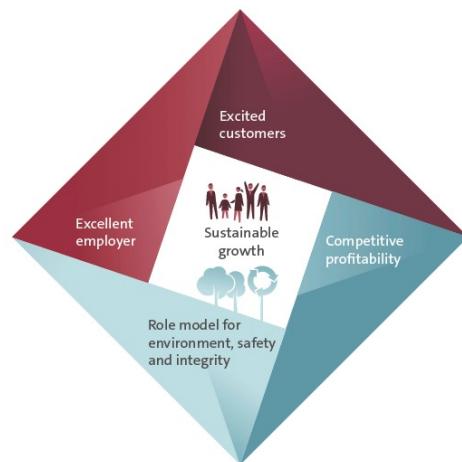


Decarbonization



GO.FAIR

Fair society – our responsibility



Mobility

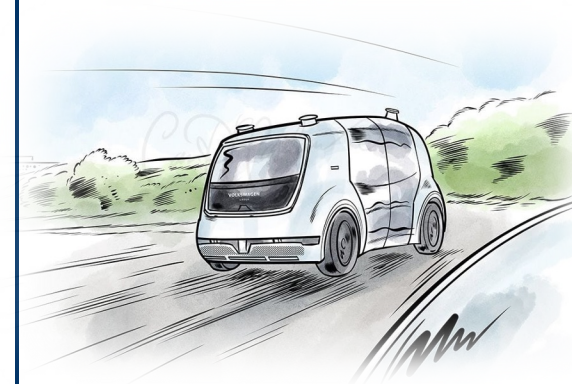
GO.FAR

Long-distance mobility



GO.CITY

Urban mobility systems



Strategic Partners in Knoxville

The University of Tennessee Knoxville



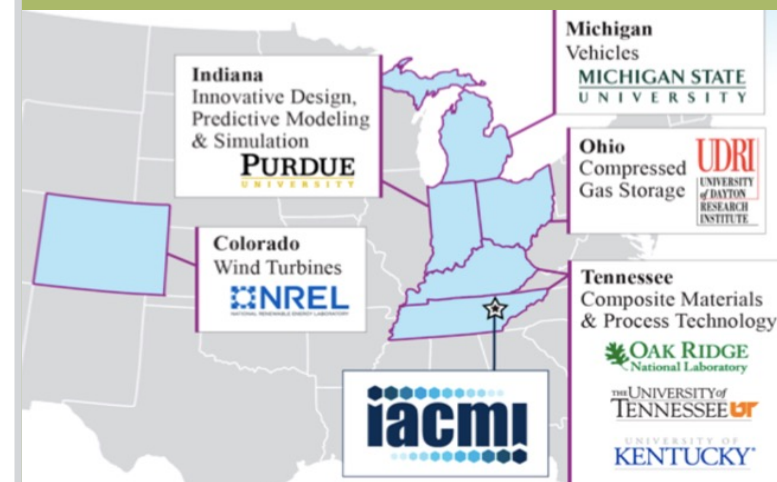
- Master Research Agreement
- Volkswagen-UTK PhD Fellowship
- \$ 1.1 Billion Funding UT Research

Oak Ridge National Laboratory (ORNL)



- Cooperative R&D Agreement (CRADA) signed in 2021
- \$ 2.4 Billion annual R&D Funding

IACMI - The Composites Institute



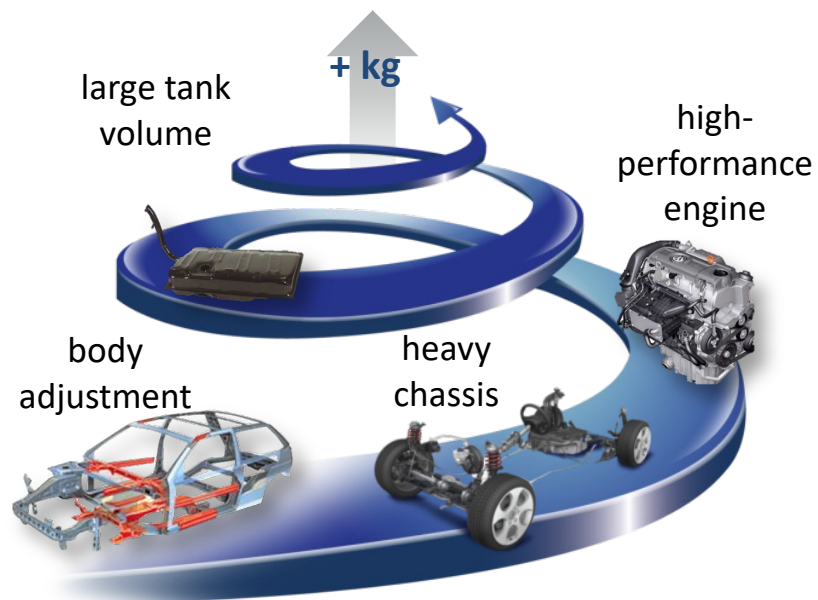
- 122 companies, universities, and research labs
- > \$ 300 Million funding since 2015

Motivation for Project 3.7



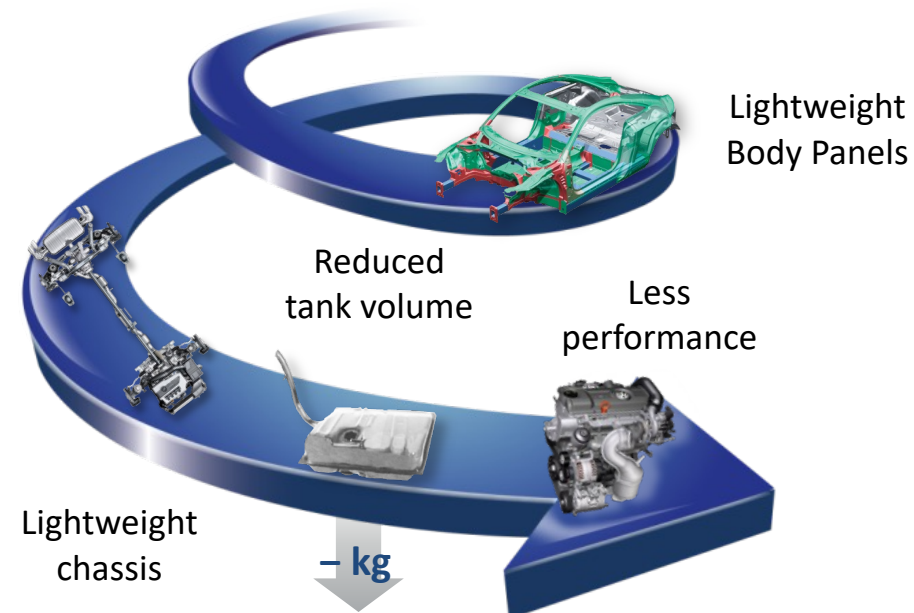
Increasing Features and Standards

- Convenience
- Safety
- Quality
- E-Mobility
- Self-Driving



Weight Savings

- Component/functional integration
- Materials and processes
- Cost/weight optimization



Project 3.7 Overview



Project

Reduction of CO2 Emissions Through Lightweight Body Panels
(SMC Liftgate for Volkswagen Atlas)



Targets

- Fulfill conventional specification requirements
- Similar weight to an aluminum version
- Part cost less than aluminum version
- Reduction in investment cost
- High volume capability:
 - >100,000 units/a
- Class A surface quality



Strategic Partners



Goal

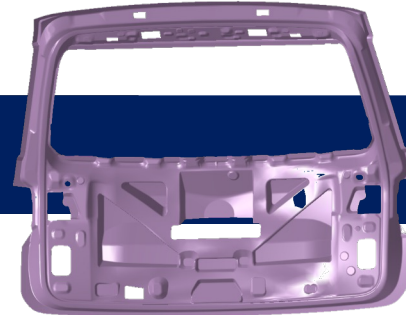
Develop full-scale demonstrator in collaboration with partners to demonstrate technology readiness

From Steel-to-Composite

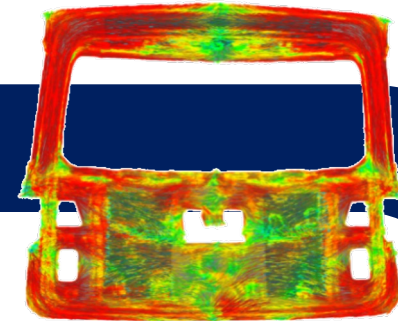
I. Start from current metal design



II. Redesign in CATIA for composite application



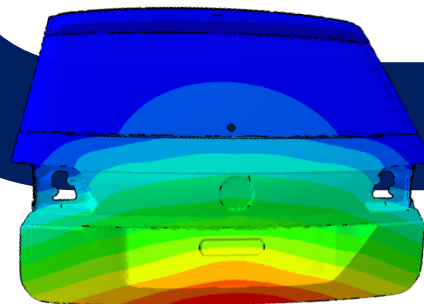
III. Predict fiber orientation with Moldex3D



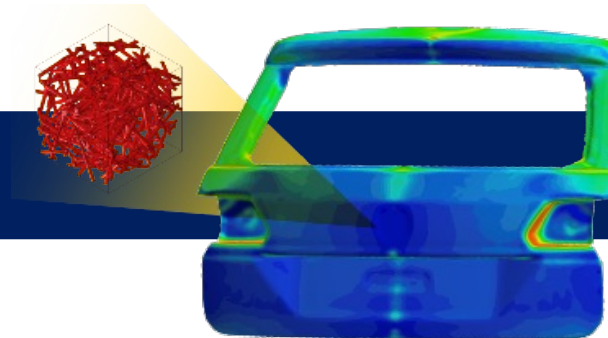
PURDUE
UNIVERSITY®

CVF

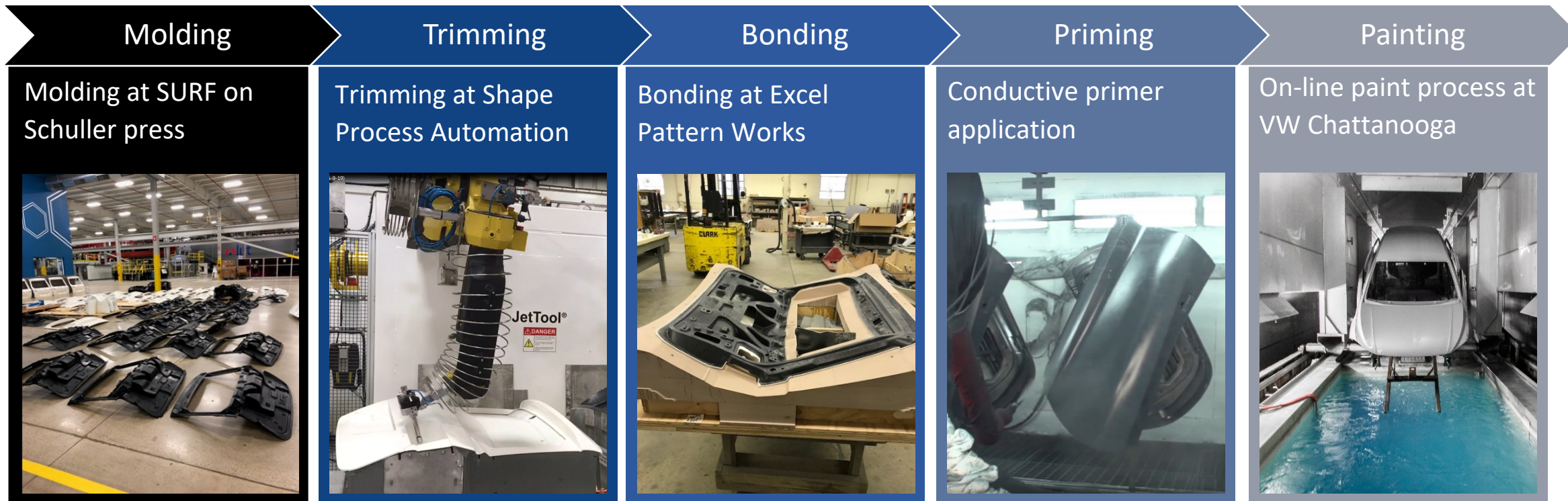
V. Predict manufacturing informed performance with Abaqus



IV. Integrate material properties with Digimat



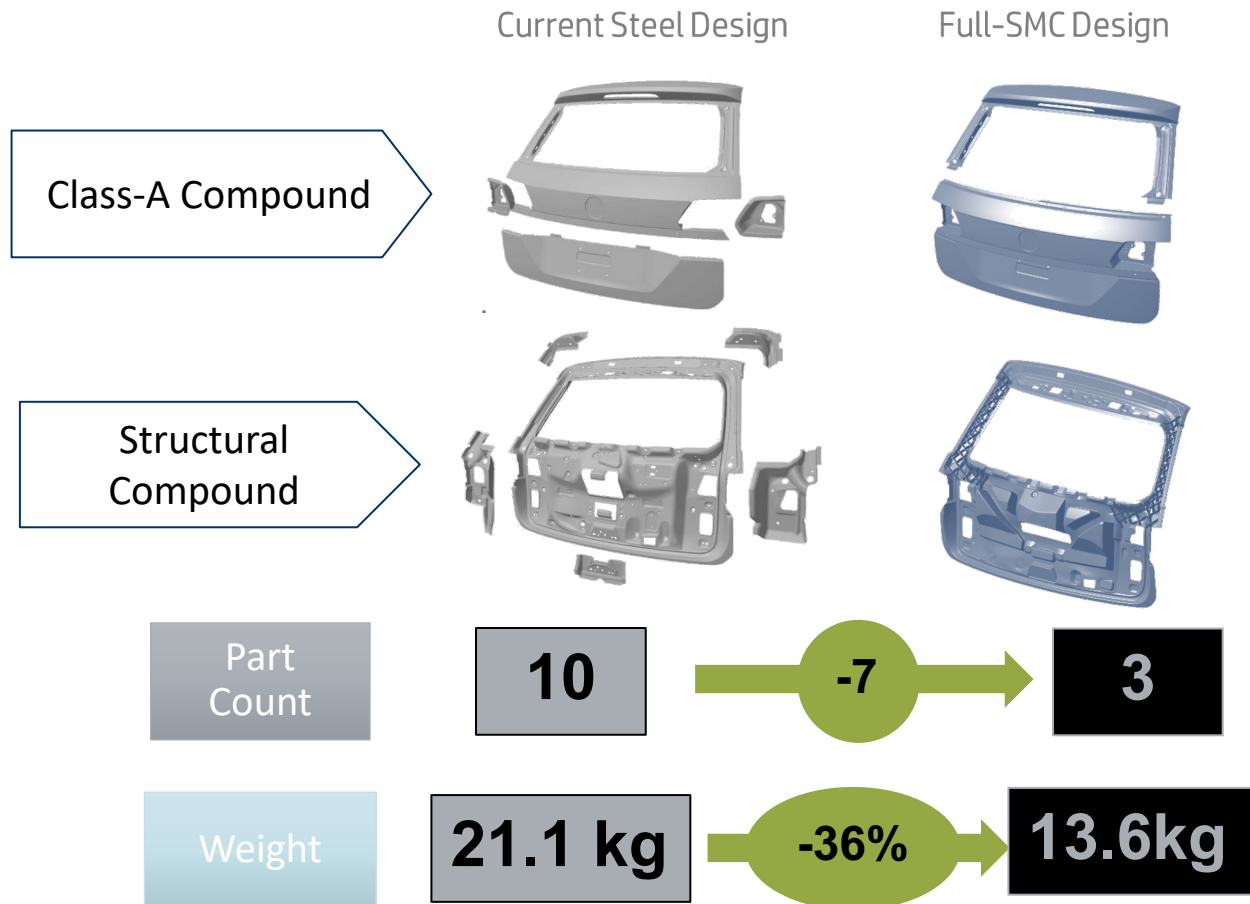
Full-Scale Demonstration Parts



- Full-scale demonstration requires capabilities that exceed one research institute or company alone
- MSU oversaw and managed all partners, process steps and external service providers

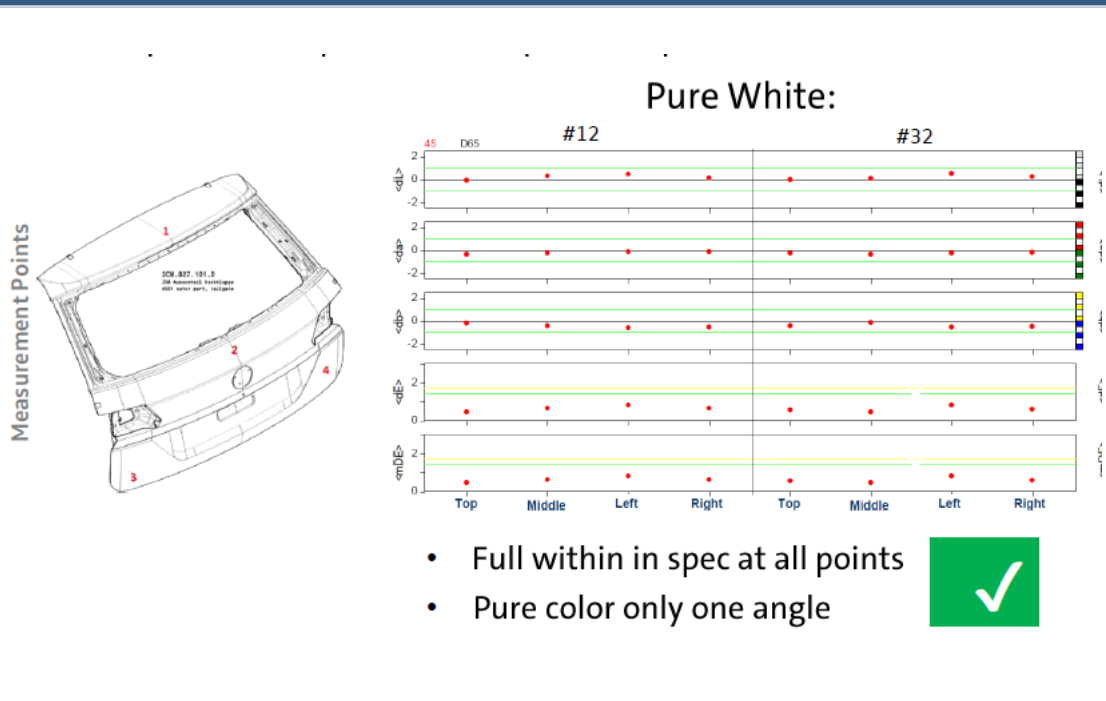
Review of Transformation

- No change to assembly sequence
- No change to painting process (E-Coat ready)
- Lower capital investment (>70% saving in tooling)
- Reduction in F-time



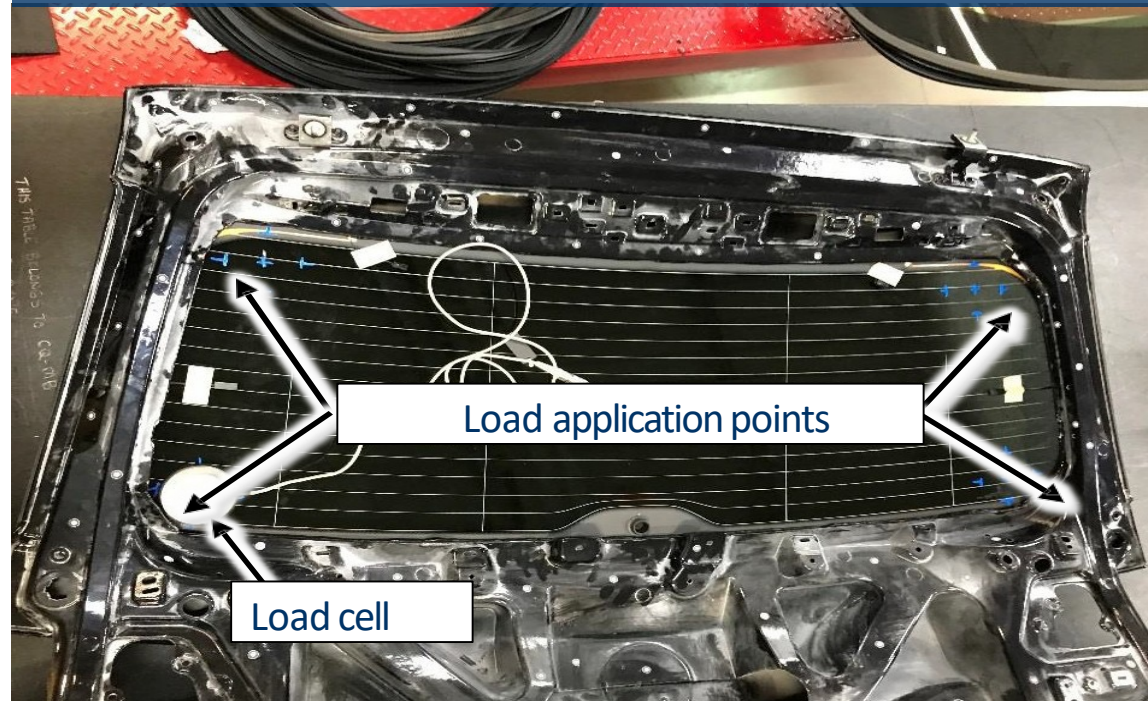
Further Validation of Technology

Color Matching Measurements (Colorimetric Evaluation)



- Two liftgates were measured and analyzed by CQ-AL in Chattanooga, TN
- No optimization performed on primer or paint

Glass Push-Out Test



- Testing all four corners
- Testing one corner



Examples of SMC in Production

Lamborghini Aventador Rear Fender



Bentley Continental GT Deck IId



Recycling & Circular Economy of Composites End-of-Life Scenario

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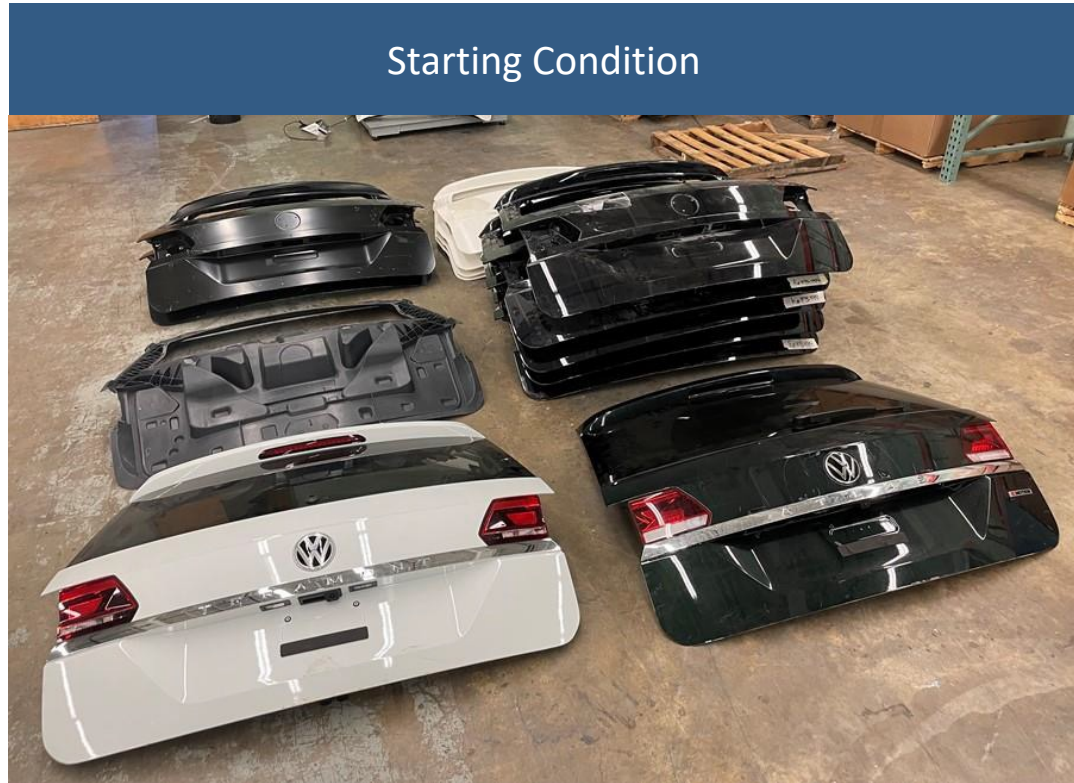
Majority of composites are made with thermoset polymers reinforced with glass and carbon fibers

These composite materials are not readily recyclable (no remolding)

Most products are landfilled after their use-phase



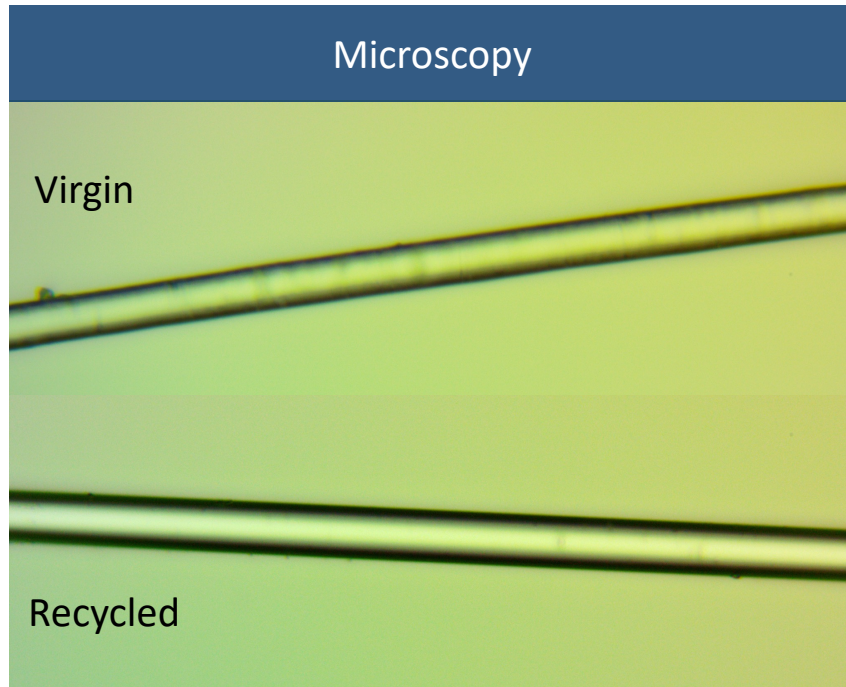
Recycling of Volkswagen Atlas Composite Liftgate Carbon Rivers



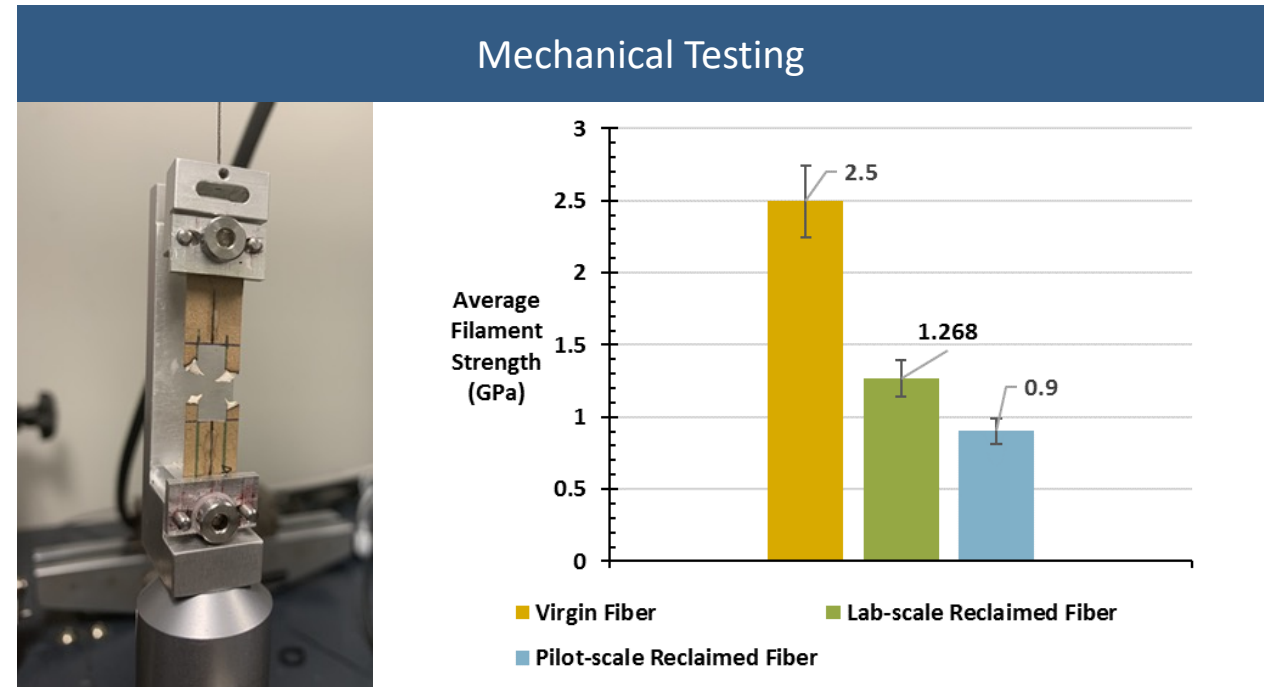
Pilot Testing Recycled Materials Recovery Carbon Rivers-Pyrolysis



Reclaimed Glass Fiber Characterization Results



- Reclaimed fiber visibly indistinguishable from virgin fiber
- Measured diameters statistically consistent across virgin and reclaimed fiber
- Microscopy and TGA results indicate no residual organics left behind



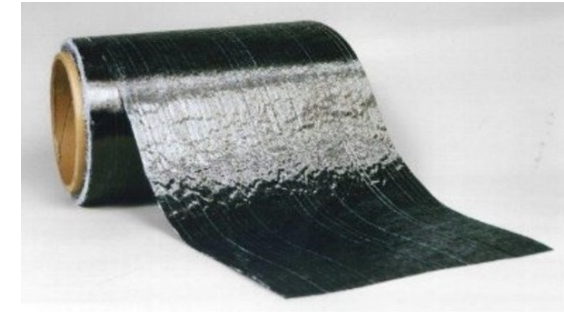
- SMC production process known to damage fiber strength during 1st lifecycle, so virgin strength should be considered upper bound of pre-cycling fiber state
- Fiber stiffness is also more degraded in pilot trial but still sufficient for reuse at 81% retained Young's modulus.

Recycling & Circular Economy of Composites



TIER 1

Chopped fiber prepreg with thermoset resin



**ENDEAVOR
COMPOSITES**

Producing
nonwoven fiber
mats

Molded
composite part

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Recycling
(
Pyrolysis)



Thank you for your attention!



For more information on these topics and Volkswagen Group Innovation please contact
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