Activated Carbon's Runway With the Internal Combustion Engine

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Ingevity

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Experienced Business and Regulatory Leadership

Ed Woodcock

Exec. VP and President, Performance Materials

- Joined Ingevity in 1988
- 32 years of global experience managing Performance Materials and Performance Chemicals product lines
- Created a regulatory advocacy program to drive emissions reductions around the world, while supporting growth of the automotive activated carbon business
- Led long-term strategic expansions of our manufacturing assets across North America and Asia
- Simplified and streamlined supply chain to support global demand and create supply efficiencies
- Positions included:
  - Vice President, Carbon Technologies
  - Global Business Director, Automotive
  - Business Director, Automotive, Asia-Pacific
  - Marketing Manager, Worldwide
  - Area Sales Manager, Latin, Central and South America
  - Technical Manager, Process Purification
- Bachelor of Science degree in chemical engineering from the University of Virginia

Mike Tschantz

Senior Director, Government Relations

- Joined Ingevity in 1996
- 25 years of global experience leading regulatory advocacy initiatives for Performance Materials
- Successfully helped establish, implement and lead Ingevity's world-class regulatory advocacy program to drive emissions reductions around the world
- Led coalition that brought about initiatives for natural gas vehicles as part of the U.S. S.A.F.E. Vehicle Rule
- Positions have included:
  - Director, Technical and Regulatory Affairs
  - Manager, Research and Development
  - Analyst, Research and Development
- Ph.D. and Master of Science in chemical engineering from the University of Tennessee - Knoxville
- Bachelor of Science degree in chemistry from Wake Forest University

Today's Agenda

1. Today's Vehicle and Regulatory Landscape
2. Challenges That May Affect the Pace of Battery Electric Vehicle Adoption
3. Our Role in Hybrid Electric Vehicle Technology and its Anticipated Growth
4. Driving Long-Term Growth of Activated Carbon in the Automotive Space
5. Q&A

1 Today's Vehicle and Regulatory Landscape

Today's Vehicle Landscape is Highly Diverse

Vehicle make-up	Internal Combustion Engine (ICE)	Mild Hybrid (MHEV)	Full Hybrid (FHEV)	Plug-In Hybrid Electric Vehicle (PHEV)	Battery Electric Vehicle (BEV)	Fuel Cell Electric Vehicle (FCEV)
Example make and model		GM eAssist Honda Insight Ford EcoBoost	Toyota Prius Honda CR-V hybrid Ford Fusion hybrid	Chevrolet Volt BMW X3 PHEV Mitsubishi Outlander	Tesla models Hyundai Ioniq electric Nissan Leaf	Toyota Miraj
ICE	✓	✓	✓	✓		
Electric assist		✓	✓	✓	✓	✓
Electric drivetrain			✓	✓	✓	✓
Plug-in electric vehicle (PEV)				✓	✓	
Tailpipe emissions	✓	✓	✓	✓		
% of 2020 global sales[1]	74.4%[2]	3.9%	3.9%	1.2%	2.8%	0.01%

Common terminology and references

- **Internal combustion engine (ICE)**
- **Hybrid**
- **"Electric vehicle" (EV) in the headlines; Meet most proposed ICE bans**
- **Zero emission vehicle (ZEV)**
- **New energy vehicle (NEV)**

1| IHS December 2020 Rivalry scenario;% 2020 global sales shown for vehicles with ICE only includes gasoline variants and excludes diesel and other nonvolatile fuel variants
2| Only gasoline and ICE flex fuel

The Current Regulatory Landscape is Dynamic

The Paris Agreement is driving net-zero activity while technology-forcing policy is driving current consumer purchases of EVs

Government actions to push electric vehicle uptake

Some countries and regions have stated targets for ZEV sales or ICE phase-outs. However, most of these countries haven't set legislation to force BEV sales. Most have outlined mobility plans or strategies to achieve targets of reducing vehicle CO_2 emissions and provide hefty incentives to purchase PHEVs and BEVs. While CO_2 emissions are reduced from the vehicle itself, they shift to those from producing battery materials and electricity to power the vehicle.

Transportation sector electrification efforts

Incentives

- Tax and fee exemptions, reductions, credits
- Purchase subsidies, registrations

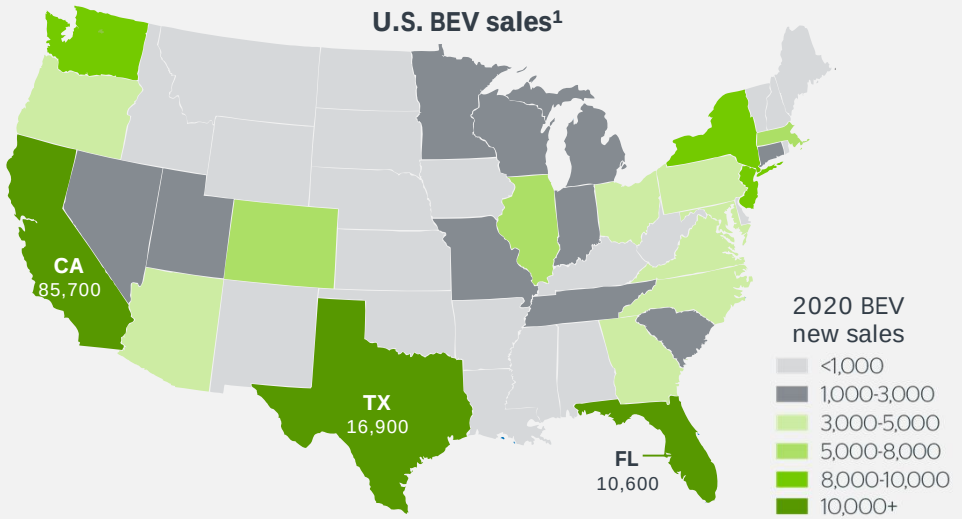
Policy options

- Fuel economy, greenhouse gas (GHG), criteria vehicle emission standards
- Clean fuel standards
- Zero-emission vehicles

Local / municipal restrictions

- ICE bans
- Zero-, low-emission zones

How incentives and policy are driving consumer purchasing patterns



Of all U.S. vehicle sales in 2020, BEV sales were only 1.5%. California was 39% of those BEV sales.

1| Alliance for Automotive Innovation

Policy – *NOT Consumer Demand* – Will Drive OEM Production Mix Shifts

China[1]

Has NEV and aggressive corporate average fuel economy (CAFE) standards

- 2025 CAFE limit: 4.6L/100km (51 mpg)
- NEV credit share of 4%-18% by 2023
- Credit-based; actual share much smaller

14th Five Year Plan released March 2021 states China will focus on CO_2 and evaporative emissions

European Union[2]

Update for CO_2 performance standards for cars and vans is expected late 2021

- Current GHG fleet limit: 95 kg CO_2/km
- 2025 onward, ZEV and LEV sales must account for 15% of new vehicle sales

Will legislate Euro 7 standards end of 2021 or later, which may include stricter standards for evaporative emissions, including ORVR

U.S.

Expected to have new, stricter CAFE and CO_2 standards under Biden administration[3]

- Current CAFE limit: 1.5% year-on-year increase

California and Section 177 states have adopted the ZEV mandate[4]

- By 2025, 22% credit-based market share must be PHEV and BEV
- Governor Newsom passed an executive order for 100% ZEV by 2035

1| China's Ministry of Infrastructure and Transportation Points Policy
2| The European Commission
3| National Highway Traffic Safety Administration
4| California Air Resources Board

2 Challenges That May Affect the Pace of Battery Electric Vehicle Adoption

EVs Have No Tailpipe Emissions but Still Impact the Environment

A mix of mobility solutions is more realistic to meet net-zero goals

Environmental impacts

Shifts – rather than eliminates – environmental impact

- Shifts CO_2 emissions from the tailpipe to the smokestack
- Shifts environmental impact to developing battery and zero-emission electricity generation materials

Increases need for renewable energy and stresses electricity grid

- Cleaner energy needed in higher quantities to accommodate charging infrastructure
- Renewable energy sources rely on batteries for storage or combustion turbines when renewables aren't available
- Uptick in EV demand creates more electricity demand, yet utility providers are trying to move to alternative sources like wind and solar

Depletes battery and magnet metals

- Battery metals and minerals[1] mining
  - Cobalt
  - Lithium
  - Manganese
  - Copper
  - Graphite
  - Nickel
- Heavy reliance on mining with human rights issues in China, Dem. Rep. of Congo, S. Amer.[2]

Hybrids and strategy mix could benefit the environment more

Four[3] future scenarios show GHG emissions projections for 2050, relative to the PA goals. **While only the "California extreme" and "Strategy mix" scenarios stay below the PA GHG goal, the "California extreme" scenario requires much larger electricity production.**

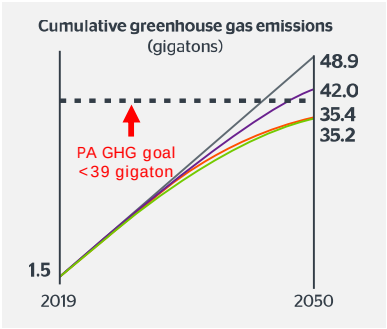
1) Business as usual
EVs <10% of new car sales by 2050

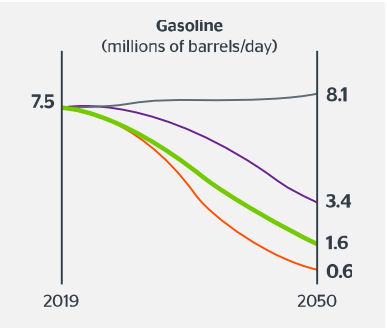
2) Cali. extreme
States push for all new cars to be EVs by 2035

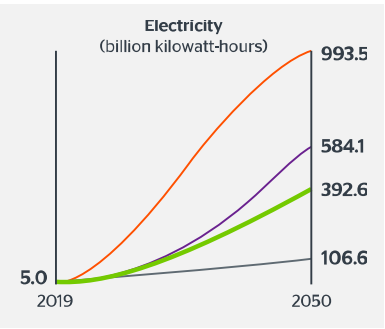
3) All hybrids
Consumers buy hybrids due to EV charging worries

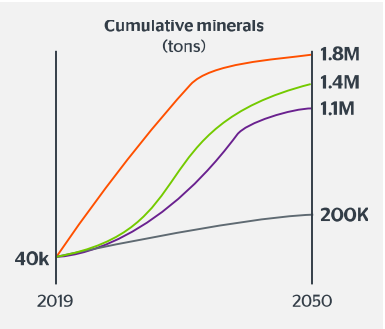
4) Strategy mix
U.S. promotes EVs; pursues strategies to lower GHGs

Largest opportunity for increased NGVT content









1| United Nations 2020 Conference on Trade and Development
3| University of Toronto 2021 study with the WSJ, March 2021
2| United Nations, June 28, 2020: "UN highlights urgent need to tackle impact of likely electric car battery production boom"

Vehicle Electrification Will Cause 'Pain Points' for OEMs

OEM reality[1]

"…Dramatic progress in electrification requires overcoming tremendous challenges, including **refueling infrastructure, battery availability, consumer acceptance and affordability…**"

Technology and resource limitations[4]

- Making EV batteries requires a large R&D and production investment
- OEMs either produce in-house or outsource batteries
- Forming joint ventures for battery production to be profitable in this area and collaborate for better knowledge

Workforce impacts[4]

- OEM workforce challenges due to need for employees and supply chains capable of producing electric and ICE vehicles
- Operating without certainty of when policy will force stronger production of either electric, ICE or mix

Desire certainty through policy[4]

- Concerned with maintaining share, selling vehicles
- EVs are an expensive investment
- Traditional OEMs are looking for valuation to compete with Tesla

Profit and competitive pricing[3]

- Price differential driven by raw material costs to produce batteries
- PHEV are ~$12,000 more costly to produce than ICE vehicles
- Government subsidies for manufacturers and supply chain have been used in China to encourage more EV production

Selling BEVs[2]

- 3 out of 5 consumers are noncommittal about considering an EV for their next purchase
- Consumers who plan to buy a BEV have never sat in one
- Strong/large incentives required to boost interest/purchases

1| Reuters, Toyota warms rivals' gasoline engine phase-out goals must overcome huge challenges, March 16, 2021
2| 2021 J.D. Power Electric Vehicle Consideration Study
3| McKinsey & Company, Making Electric Vehicles Profitable, March 2029
4| BCG, Shifting Gears in Auto Manufacturing, September 28, 2020
Additional source: Ingevity management information

Consumer Interest and Demand for EVs is Uncertain

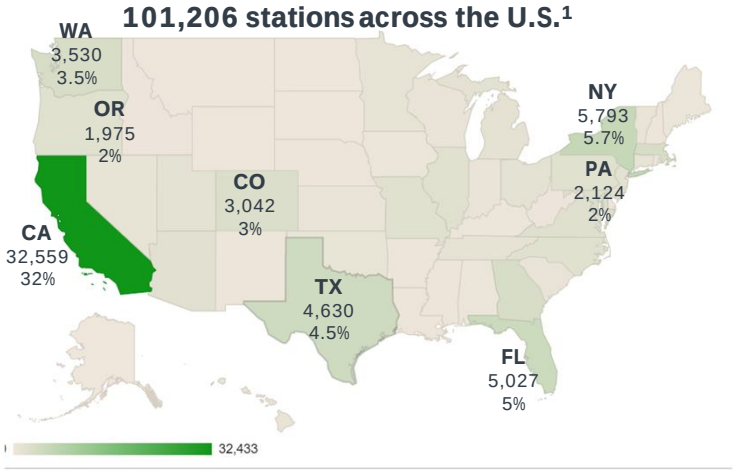
- High upfront vehicle cost; residual value and battery pack replacement cost unknown
- “Range anxiety” due to lack of charging and refueling infrastructure
- Insufficient supply and model options
- Concerns for safety and ability for mechanics to fix EV issues
- Don’t necessarily believe EVs are better for the environment
- EV sedan purchasing is contrary to current consumer demand for larger trucks and SUVs

Source: 2021 J.D. Power Electric Vehicle Consideration Study

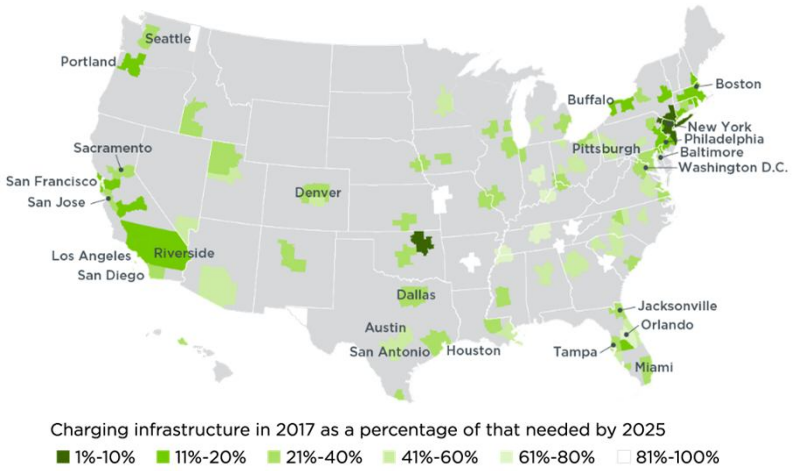
The EV Charging Infrastructure Is Inadequate and Concentrated in Urban Areas

Gasoline stations becoming charging points overnight is a stretch

U.S. public access charging stations



Public and workplace charging infrastructure in the U.S.'s 100 most populated cities as a percentage of infrastructure needed by 2025[2]



Charging by the numbers[3]

Charge Level	EV miles per charging hour	Charge location	Voltage	Hours to charge empty battery to 249 miles
1	3-4	Home, some work	120 AC	43
2	10-20	Home, work, public	203-240 AC	11
3 DC fast	150–1,000	Public	400+ DC/AC	1

Charging point challenges[3]

EV owners are shifting from single-family homeowners to multi-unit residence dwellers

This creates an estimated 20% increased need year over year for additional shared (public and workplace) charging stations to meet projected EV growth by 2025

Charging at home costs roughly $3-$8 per fill compared to $7-$36 at a public charging station

1| U.S. Department of Energy's Alternative Fuels Data Center
2| International Coalition of Clean Transportation, August 2019
3| ChargeHub

The Journey to Electrification Will Face a Wide Variety of Challenges

Among others, four key components must align for EVs to take hold

Areas of alignment needed for EVs to gain stronger traction

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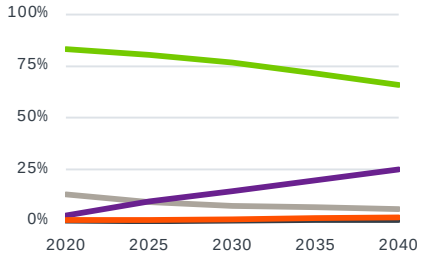
3 Our Role in Hybrid Electric Vehicle Technology and its Anticipated Growth

Forecasted Volume of ICE-Containing Vehicles Plateaus but Remains Steady Through 2040

ICE-containing vehicles include ICE, MHEVs, FHEVs and PHEVs

Percent of total vehicle sales by fuel type



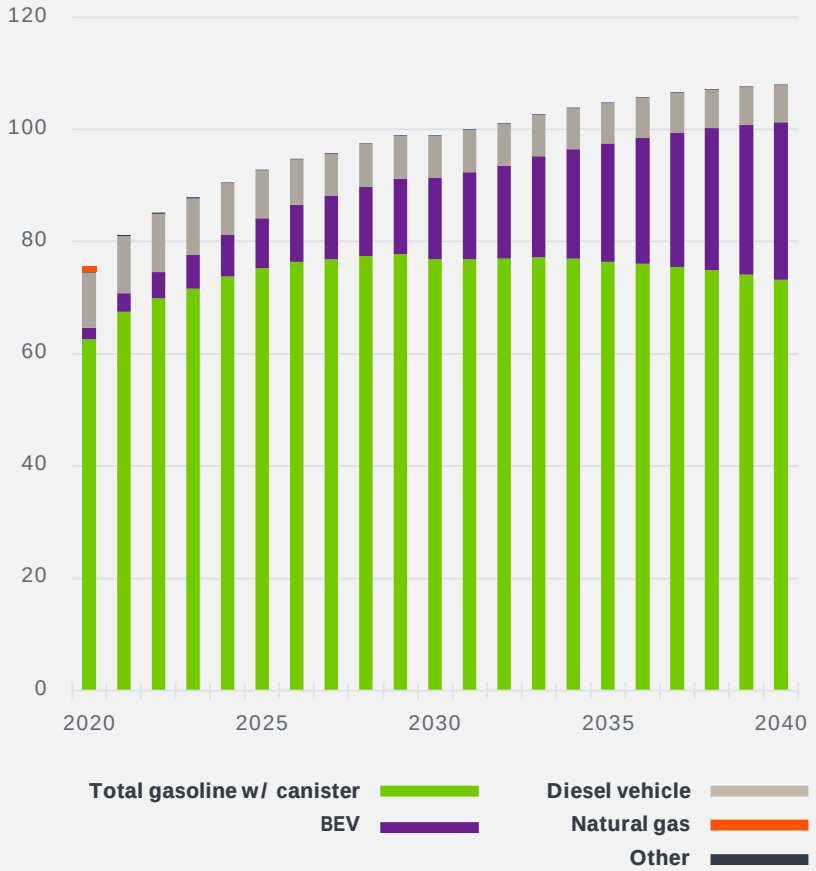
Powertrain mix shifts

By 2030, gasoline-using vehicles' and diesel vehicles' shares decline by 660 and 550 bps respectively; battery electric vehicles' share increases 1,170 bps. **Overall vehicle sales growth offsets gasoline share to maintain an annual sales rate of ~75 million/year.**

Carbon canisters

Gasoline-using vehicles (standard ICE and electric hybrids) continue to be the primary power source thru 2040.

New vehicle sales by fuel type



Non-gasoline, million vehicles 2020-2040

Diesel: 168M, 8%
Battery EVs: 311M, 15%
Natural gas: 24M, 1%
Other: 8M, 0.4%

Gasoline (ICE + Hybrids)

Over the 20-year period, IHS forecasts **1.56B gasoline-using vehicles** sold globally.

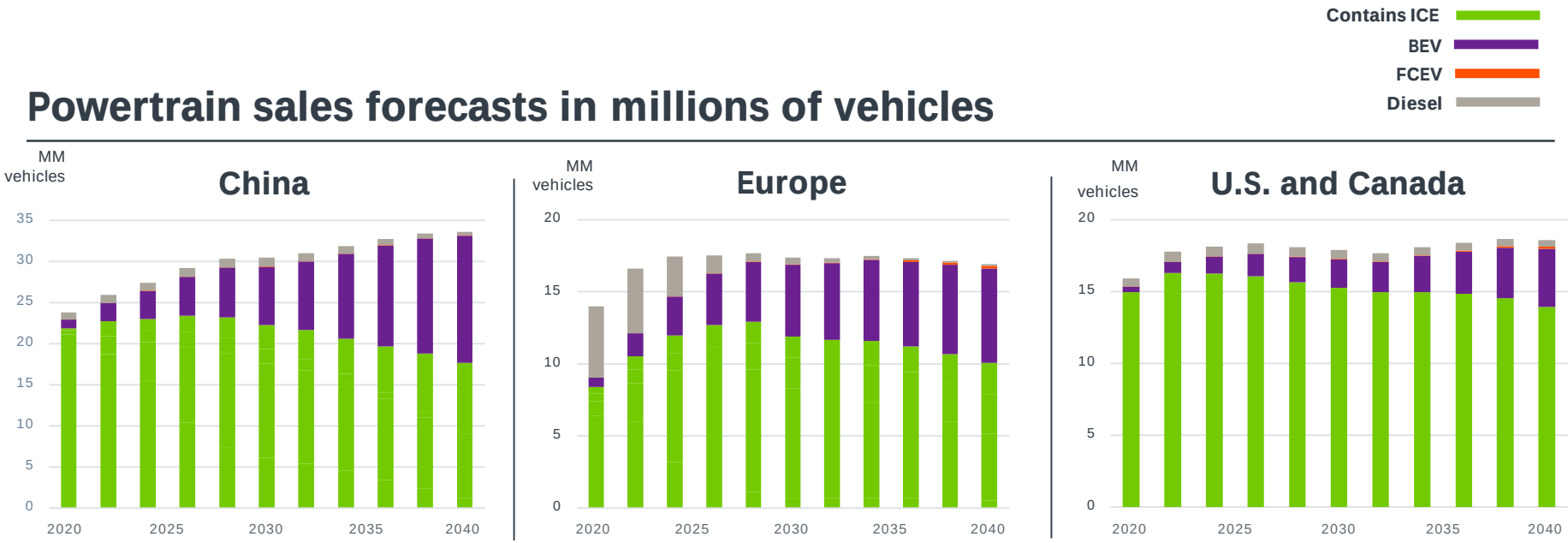
This represents 75% of the world's vehicle sales.

Source: IHS December 2020 Rivalry data

ICE-Containing Vehicle Mix Varies by Region

Vehicles requiring carbon are still the predominant percentage of forecasted sales in the world's largest automotive markets

Powertrain sales forecasts in millions of vehicles



Vehicles sold between 2020-2040 that will still require activated carbon

China	Europe	U.S. and Canada
71%	**66%**	**85%**
449.8M vehicles	238.5M vehicles	321.5M vehicles

Source: IHS December 2020 Rivalry data

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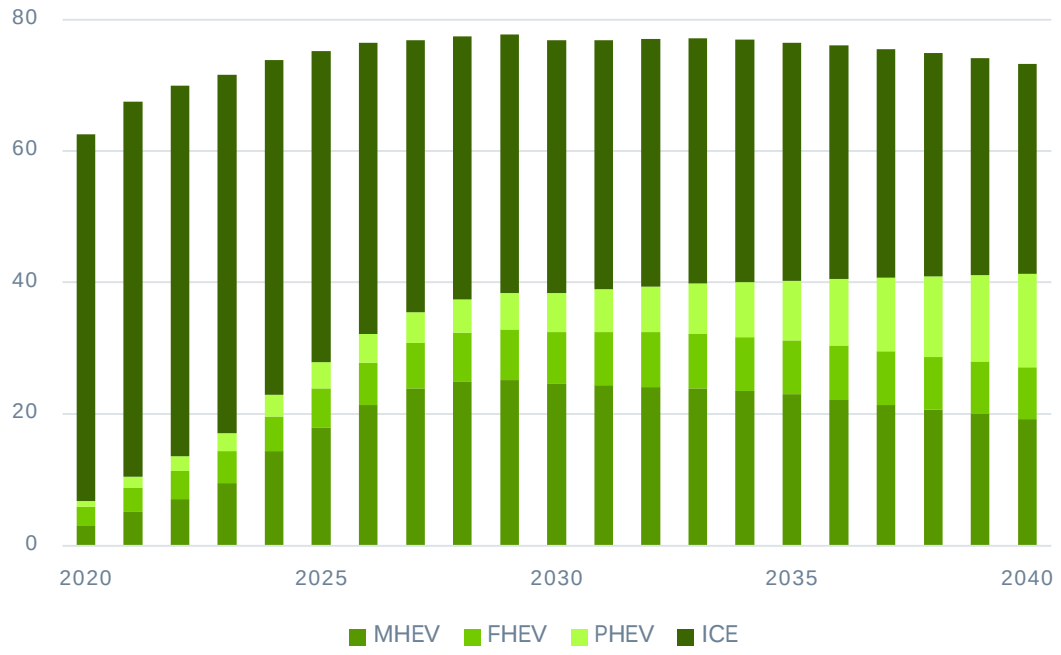
PHEVs and Hybrids Show the Most Significant Growth Among Gasoline-Powered Engines

As they will be essential in GHG goal and fuel efficiency compliance

Gasoline-burning vehicles include mild and full hybrids, PHEV and gasoline ICE.

Hybrids and PHEVs will be used to comply with GHG goals and fuel efficiency standards. Carbon canisters on these vehicles will have to meet increasingly stringent volatile organic compound (VOC) emission standards.

Million gasoline vehicles with carbon canisters / year – worldwide



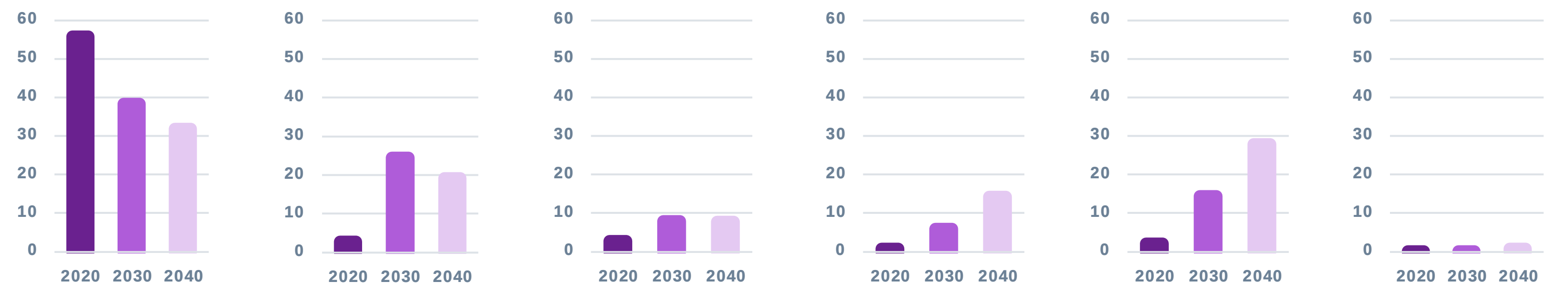
Source: IHS December 2020 data

Hybrid Electric Technologies Require More Complex Canister Design Solutions

And this advanced carbon-product mix significantly benefits Ingevity

	Internal Combustion Engine (ICE)	Mild Hybrid (MHEV)	Full Hybrid (FHEV)	Plug-In Hybrid Electric Vehicle (PHEV)	Battery Electric Vehicle (BEV)	Fuel Cell Electric Vehicle (FCEV)
Avg fuel tank size ratio to same vehicle model and powertrain[1]	1.0	1.0	0.7 – 1.0	0.7 – 1.0	N/A	N/A
Ingevity content per vehicle[2] **Depends on**: - Gas tank size - Engine purge - Reg. tier	**$18-$44**	**$18-$44**	**$10-$33**	**$9-$13**	**$0**	**$0**

Forecasted new vehicle sales[3]
(in millions)



1| Fueleconomy.gov and management analysis
2| Based on ORVR and TIER 3 regulations
3| December 2020 IHS Rivalry Scenario

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4 Driving Long-Term Growth of Activated Carbon in the Automotive Space

Automotive Market Growth Drivers

Short-term drivers

- Annual sales rate and increasing product value
- Continued shift to larger vehicles like light trucks and SUVs
- Opportunity to simplify via global harmonization

Long-term drivers

- Continued growth in hybrid vehicles globally
- Increasingly stringent emissions regulations
- New engine technology, intellectual property (IP) and IP defense
- Ingevity's activated carbon advantages
- The sustainable nature and environmental benefits of Nuchar® technology

Short-Term Driver

Annual Sales Rate and Increasing Product Value

The number of vehicles benefiting from Ingevity content is expected to increase in the near term, as does the value of content.

Strong ongoing ability to capture product value

- Reduce production costs through operational excellence
- Continue to build customer preference through unfailing quality and supply; simplify and streamline supply chain
- Negotiate long-term supply agreements
- Ensuring capacity to meet growing global demand

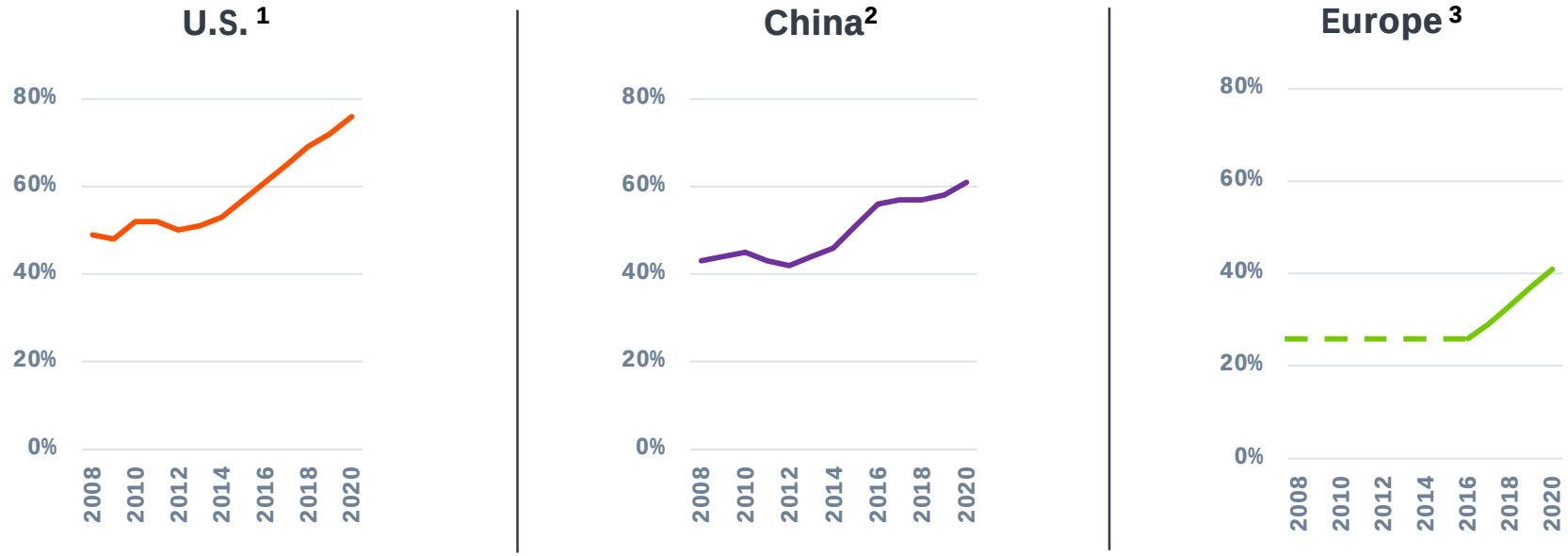
ICE FHEV
MHEV PHEV

Source: December 2020 IHS Rivalry Scenario

Short-Term Driver

Consumer Demand is Driving a Shift to Light Trucks and SUVs

Light-duty mix shifts



Consumer demand has been shifting toward larger vehicles for some time, creating a challenge for BEVs, since most are cars today with minimal SUV or light-duty truck options

1| Ward's Automotive
2| IHS light vehicle production database; management analysis
3| Automotive News Europe

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Short-Term Driver

OEMs are Likely to Simplify via Global Harmonization

Concept of harmonization[1]

Vehicles sold and put into service in a country must meet the regulations and standards of that country.

The existence of separate national regulations and approvals in different countries means expensive design modifications, additional tests and duplicating approvals.

There is a need to harmonize the different national technical requirements for vehicles and to elaborate a unique international regulation.

Once the vehicle, its equipment and/or parts are manufactured and approved according to that regulation, they can be traded without further tests or approvals.

Benefits[2]

- Creation of substantial **synergies and cost reductions**
- Better **ensure comparability across markets**
- **Enable other regions to apply and adapt existing proven regulations** without regulatory divergence of countries

The United Nations Economic Commission for Europe (UNECE) 1958 agreement[1,2]

Allows reciprocal recognition of vehicle type approval or certification among parties

Includes 24 non-EU countries excluding the U.S., Canada and China

All parties would voluntarily follow the EU's lead when moving toward stricter ORVR

The 24 non-EU countries members represented ~10-12% of total 2020 vehicle sales globally

1| United Nations Economic Commission for Europe
2| International Organization of Motor Vehicle Manufacturers

Long-Term Driver

Regulations Across the Globe Will Continue to Become Increasingly Stringent

Continue to drive demand for Ingevity's products

Global emissions standard tiers

Tier 1

0.5-1.3L
One-day or two-day parking
$1-3 of NGVT content

~40%[1] of vehicles globally still run on 1970s/80s technology

Tier 2

2.0-3.0L
Multi-day parking & running loss
+ refueling control
$6-10 of NGVT content

Tier 3

2.0-3.0L + Scrubber
"Near Zero"
$12-40[2] of NGVT content

Potential for new regulations by country and region[3]

Region	2021	2022	2023	2024	2025
South Korea (1.8 mm vehicles)	←Near-zero				
Japan (4.1 mm vehicles)	Multi-day				
Brazil (1.7 mm vehicles)		Multi-day	ORVR / Tier 2 Plus		
Europe (9.1 mm vehicles)				ORVR →	
China (21.0 mm vehicles)				Near-zero →	
India (1.6 mm vehicles)				Multi-day →	

ENACTED
Regulatory requirement

POTENTIAL
NGVT management estimate

1| December 2020 IHS Rivalry scenario
2| Depends on fuel tank and purge
3| Ingevity management estimates
4| Ward's Automotive

Long-Term Driver

New Engine Technologies, IP and Defending Our IP

'649 patent family update: low-purge engine technology

- '649 patent family designed to enable low-purge engines to meet the near-zero emissions standard within a much more challenged engine environment
- 15% - 30% of U.S./Canadian vehicles already fall under patent; anticipated to grow to 25 – 60% of U.S./Canadian market, as lower purge and more hybrids grow in prevalence
- First patent issued in August 2017; expires 2033
- Patent filed globally
- Expect challenges; will vigorously defend IP

Intellectual property defense

- Continue to pursue legal actions against MAHLE and BASF to defend intellectual property rights
- The potential impact to our revenue as it relates to the expiry of Ingevity's '844 patent is minimal

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Long-Term Driver

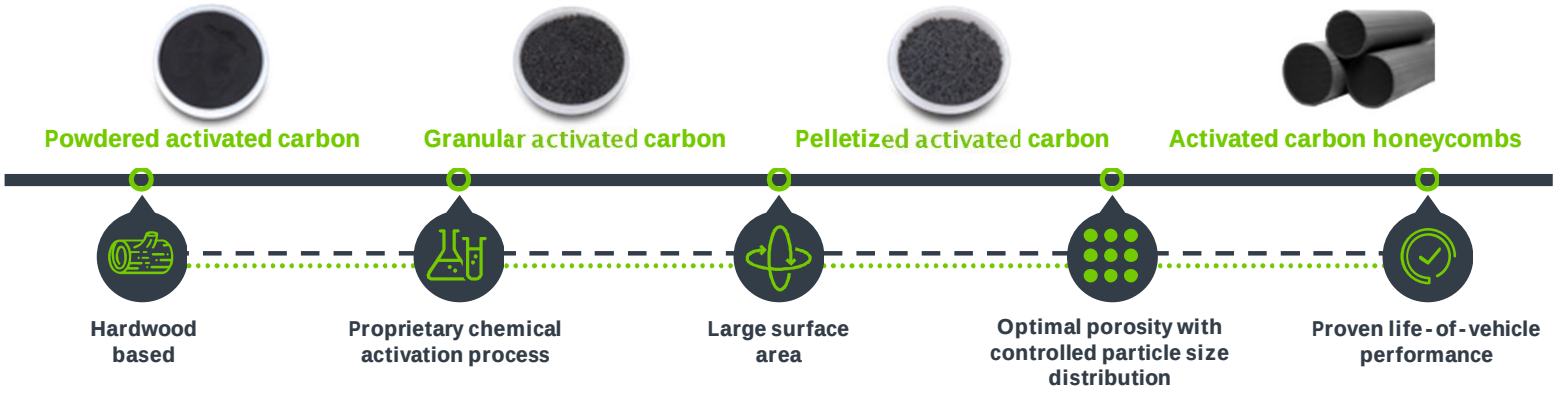
Ingevity's Carbon Technology Advantage

Unique processes and product features are the secret sauce

40 years of technology leadership and expertise

- Deep customer relationships with Tier 1 suppliers and OEMs; Offer customers comprehensive portfolio and innovative solutions
- History of quality and reliability, with our products used on 1+ billion vehicles worldwide without a recall
- Considered global expert on regulatory issues and evaporative emissions; Early insight into future engine design and emissions control regulations
- Robust innovation and IP development engine
- Operate multiple hardwood sawdust/acid carbon activation facilities to supply key U.S. and China markets
- Potential entrants face an uphill climb related to cost to build, technical expertise, engineering talent, and reputation

Proprietary, unmatched product features of Nuchar®



Added Value

Our Nuchar® technology is also quantifiably benefiting the environment through GHG and VOC emissions reductions

Long-Term Driver

The Sustainable Nature and Environmental Benefits of Our Nuchar® Technology

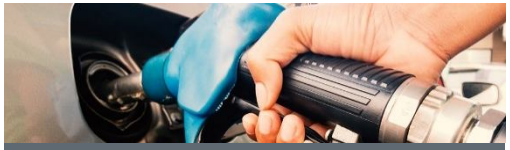
Sustainable nature of Nuchar

Renewable Raw Materials

Hardwood Sawdust + Phosphoric Acid

Nuchar technology

Powdered activated carbon | Granular activated carbon | Pelletized activated carbon | Activated carbon honeycombs



Market applications

- Water treatment
- Food and beverage
- Chemical and pharmaceutical
- Automotive applications
  - **Tier 1**: canister solutions
  - **Tier 2:** ORVR refueling solutions
  - **Tier 3, LEV III:** near-zero solutions

Environmental benefits in automotive applications

GHG reduction impact[1]

10 times

Offsets the volume of GHG in the manufacture of Nuchar and that of the carbon-containing canister **by a factor of 10**

>5 million metric tons of CO_2-equivalent

Avoided from polluting the air over the vehicle's life

VOC reduction impact[1]

>20,000 metric tons of VOC emissions

Prevented from emission into the atmosphere daily by Ingevity products in use today, which is **equivalent to returning 8 mill gallons of gasoline daily** to power vehicles

By capturing these VOCs with Nuchar, they lose the ability to become ozone precursors, secondary organic aerosols or hazardous air pollutants

Value beyond vehicles

And our activated carbon technology can also benefit applications beyond the automotive space

1| ERM lifecycle analysis, 2020

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The Runway for Activated Carbon:

Confidence in strong, long-term growth

- 40 years of technology leadership; Ingevity is widely recognized by regulators around the world as the leading experts in gasoline vapor emission control
- A reputation of superior quality and consistency that makes Ingevity the safe choice for OEMs
- Significant global opportunity for increased stringency in emissions regulations driven by ongoing advocacy
- Continued innovation in automotive and beyond; continued new patents; continued defense of intellectual property
- Outstanding history of strong financial results, growth and profitability

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