Ideanomics

2023

MARKET TRENDS & INSIGHT REPORT

The 2023 Market Trends and Insights report provides unique perspectives from Ideanomics's leaders and technical experts on the opportunities and challenges for the commercial adoption of electric vehicles.

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> “Securing orders, controlling costs, and delivering on product timelines are indicators the market will be looking for to understand who will struggle to survive, and who will execute and thrive.”

ALF POOR

Chief Executive Officer, Ideanomics

TRANSITIONING TO EV DURING AN ECONOMIC DOWNTURN

Cleantech attracted massive investor interest in 2020 and early 2021, with many special purpose acquisition companies (SPACs) and initial public offerings (IPOs) adding to the incumbents in the industry.

Electric vehicles are a critical part of cleantech, and an influx of new entrants in the market created saturation. The challenging economic and market conditions facing the entire EV sector, which began in February 2021, will result in much-needed consolidation. However, the power players who emerge on the other side will benefit investors and EV-buying audiences.

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POLICY IS POWERING THE PATHWAY TO EV ADOPTION

Government support will be mission-critical to EV adoption, particularly in the commercial sector.

In both the United States and Europe, policies are in place to advance the EV market's full potential. However, the most meaningful policies are still in their infancy, starting with the Inflation Reduction Act (IRA).

Among its many benefits, the IRA provides funding to support low-income and disadvantaged communities across the United States. This is critically important, as the communities facing the greatest impact of climate change and air pollution are often the slowest to realize the benefits of clean technology deployment. Additionally, the IRA provides incentives and grants for packaged solutions, which is exciting given Ideanomics's development of a fully integrated, end-to-end EV and charging product offering.

The National Electric Vehicle Infrastructure (NEVI) program from the United States Department of Transportation and Federal Highway Administration is another strong example of a policy that can be meaningful for the EV industry.

Durable, dependable and geographically appropriate charging networks in the United States will be critical for the future of the EV industry, whether fueling up for family road trips or transporting food and large appliances through commercial long-haul trucks. An enhanced program for commercial van and truck subsidies is necessary to advance EV deployment. The voucher programs we have seen to date have been helpful but have been heavily oversubscribed and exhausted within days of launch.

> **"It's like trying to get tickets to a Taylor Swift concert—someone's always going to be left out and disappointed, despite showing up on time and registering their interest."**

ALF POOR
Chief Executive Officer, Ideanomics

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> “The key to navigating these challenges is robust and reliable partners in the supply chain. At Ideanomics, we maintain supply chain teams in the geographical locations where the components are produced. This helps us develop and streamline our supply chain to overcome today’s and tomorrow’s challenges.”

ALF POOR

Chief Executive Officer, Ideanomics

A RESOLUTION OF SUPPLY CHAIN COMPLEXITIES WILL SIMPLIFY THE EV INDUSTRY

Microchip shortages in recent years have rendered suppliers unable to meet the growing demand from the EV industry. As more semiconductor plants are brought online in the medium-to-long term, additional infrastructure will finally meet increased industry demand. In the near-term, other supply chain issues like batteries and copper will also require significant investment in factories.

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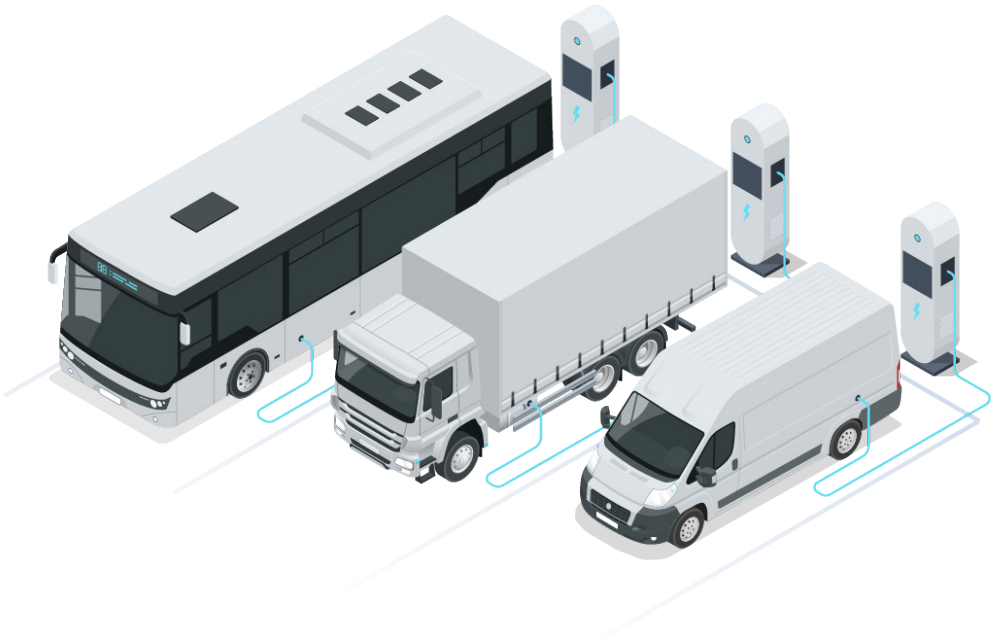
THE FUTURE OF CHARGING

Unlike consumer EVs, commercial fleet operators face unique charging challenges. Topics to consider? Charging infrastructure uptime, charging vs. operating, energy management and power availability on site.

Recentering focus with less range anxiety more operational resiliency.
Range anxiety is a common concern for consumer vehicle charging, but for commercial operators, smart energy management assets that lower the total cost of ownership and enhance operation resiliency are also mission critical.

Energy management services are key.
The ability to avoid demand charges from charging at high peak times saves money. Combined with battery storage and renewable energy generation, future electric fleet operators will generate additional energy throughout the day to use for the operation of their vehicles further reducing the total costs of ownership of operating an electric fleet.

By 2040, all new commercial trucks sold in the U.S. must be zero-emissions vehicles. By today's numbers, that means 8 million commercial fleet vehicles operated by 2 million operators in the United States must be electrified.



Charging pad images have been altered to replace WAVE's former logo with WAVE's current logo.

DEEP DIVE: WIRELESS & CONTAINERIZED CHARGING

Wireless charging is a mature technology with the potential to save commercial fleets a lot of money in operation and maintenance costs. Notably, the SAE recently released a new document, standardizing wireless charging for heavy-duty electric vehicles.

"Our company, WAVE, is the market leader in commercial wireless charging technology. We have invested in the company to increase production capacity and strengthen collaboration with leading OEMs," said Jan Freimann, Senior Vice President of Ideanomics Energy.

Where wireless charging makes sense is for example for electric fleets with long duty cycles that operate on a fixed route. With WAVE wireless technology, they can quickly charge in-route at defined stops for a few minutes. This allows transit operators with electric vehicles to reach the same range as with their diesel vehicles.

> **"Two opportunities I am excited about include further commercialization of wireless charging and introducing our scalable fast-deployable charging container to the US market."**

JAN FREIMANN

Senior Vice President, Ideanomics Energy

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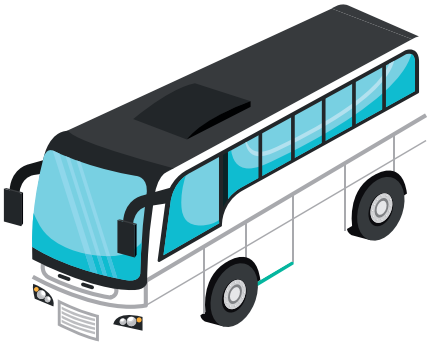
THREE AREAS WHERE WIRELESS CHARGING MAKES SENSE

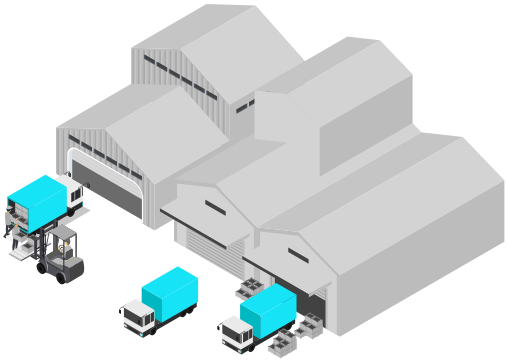


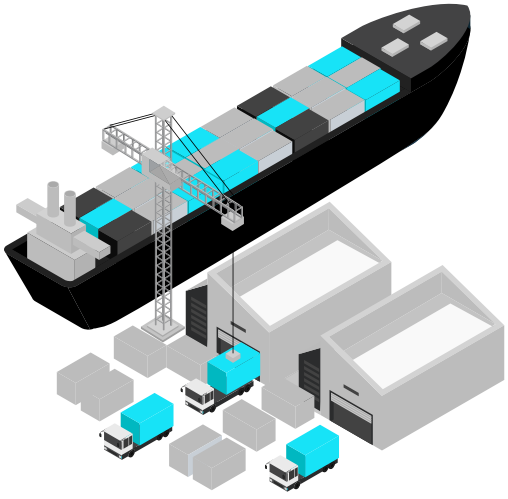
Electric bus fleets

Antelope Valley Transit Authority, which operates one of the largest electric bus fleets in the country currently uses our WAVE wireless charging system in 57 vehicles for in-route-charging. They recently achieved 10 million electric miles driven, powered by WAVE's wireless charging technology.

Middle mile delivery operations at warehouses and distribution centers

Space is at a premium at these facilities, and wireless charging fits in seamlessly because it is embedded in the ground, and the charging starts and stops automatically without any driver interaction. Electric commercial trucks can top off their charge while loading and unloading, also called opportunity charging, allowing for reduced battery sizes and no driver interaction with charging infrastructure.





Ports

Ports have highly restrictive space limitations, which is why wireless charging embedded in the ground makes sense. In the Port of Los Angeles, WAVE powers container handlers via wireless charging pads in short periods between the loading and unloading process.

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POWERING A NEW PATH: CONTAINERIZED CHARGING

Containerized charging is an entirely new way to think about EV charging. It is a portable plug-and-play solution that scales with fleet operators' needs and can be deployed fast, easily and affordably almost anywhere.

Containerized charging addresses three big challenges:

Real Estate
Today, most charging solutions are installed directly into the ground or a building. This approach has higher upfront cost and requires extensive permitting work. Containerized charging eliminates this problem and offers in addition significant O&M savings. These future-proof containers do not require permanent installation and can be picked up, moved, and redeployed anywhere.

Speed of Deployment
It can take over a year for a fleet to install charging infrastructure on the ground. Containerized charging can be deployed much faster. A containerized charging unit can be ready to start charging when your first electric truck starts rolling.

Scalability
Right now, most electric fleets are in their infancy, and companies are running pilot programs to get fleet operators and drivers comfortable with the technology. Containerized chargers are upgradable to fit any fleet size and can keep pace with the rapid transition to the all-electric fleet.– it's that simple.

> **"Installing fixed charging infrastructure in the ground or a building can take well over a year-- that's a long time to wait. Containerized charging can be deployed much faster. When you buy your first electric truck, Ideanomics Energy can build a containerized charging unit offsite that's ready to operate on Day 1."**

JAN FREIMANN
Senior Vice President, Ideanomics Energy

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POWERING A NEW PATH: CONTAINERIZED CHARGING

Ideanomics has transformed a 20-foot-high cube shipping container into a high-power portable charging solution for commercial fleets. The unit can be easily deployed and moved.

Each container is fitted with 1 to four 600kW power blocks, providing up to 2.4MW of power per container. Units are designed to withstand inclement weather conditions.

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IDEANOMICS MOBILITY

Ideanomics owns six EV companies, and we will continue to pursue strategies to realize maximum value from each of them. Energica, Solectrac, Treeletrik, Wave, VIA and US Hybrid represent billions of dollars in potential revenue generation and shareholder value.

"Where I see the biggest potential is light and medium-duty commercial vehicles. BloombergNEF projects that more than 1 million battery-electric light and medium-duty vehicles will be on the road in the United States by 2030. We believe these estimates are conservative, but nevertheless my goal is to make sure as many of these vehicles as possible are VIA vans and trucks, utilizing Ideanomics charging solutions," said Robin Mackie, Chief Operating Officer of Ideanomics.

Long-term opportunities include the integration of WAVE on the VIA platform and bringing a unified EV and charging product offering to major customers. For example, the combination of VIA electric work trucks and Ideanomics's advanced containerized charging units underpinned by the company's "as-a-service" model. Ideanomics Mobility is also exploring potential opportunities to utilize VIA's VDRIVE™ skateboard with non-competing OEMs.

"Ideanomics is laser focused on becoming a trusted partner to help commercial fleet operators electrify fast, easily and affordably. We do this by building a better EV. That means bringing to market the best vehicles featuring the best technology, offering an integrated product offering and pioneering advanced digital and design solutions."

ROBIN MACKIE
Chief Operating Officer, Ideanomics

PLANNING FOR A DIGITAL FUTURE

The digital space is exciting and necessary for EV companies. 2023 will also see the ongoing advancement of digital solutions, approaches to vehicle design and financial models. Ideanomics is collaborating with Google Cloud to develop a technology-neutral Energy Cloud Platform to allow fleet operators to securely track and manage all aspects of their EV and charging operations in one dashboard. Technology neutrality is key.

Almost all digital solutions available to fleet operators right now are locked to a specific product. This simply doesn't work for modern fleet operators because they use multiple solutions from different vendors. Ideanomics will break this barrier.

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“When coming to a dealership, EV buyers are expecting to see the greatest thing since the Ford Model T. Expecting it to work just as hard as diesel for a little more cost.”

MANI IYER

Chief Executive Officer, Solectrac

SPECIALTY SOLUTIONS, SPECIALTY VEHICLES

Planting seeds for a sustainable future: agricultural and utility vehicles

The growing popularity of EVs across the consumer sector is paving the way for the electrification of agricultural and utility machinery. Currently, customer demand can be divided into three categories:

- Climate change advocates and early adopters with an emotional connection to EVs
- Rationally inclined customers who realize the distinct advantages such as no noise or pollution and full torque at a low RPM
- Institutions and municipalities adhering to mandates on net zero emissions and carbon credits

Today’s customers looking to switch from diesel to electric tractors cite concerns including an electric tractor’s higher upfront purchase price, a shorter run time and running power away from a charging source. As industry technology evolves, the market will see new electric tractors with longer run times, shorter charge times, two-way charging, exchangeable battery packs and bigger electric tractors to tackle even the toughest jobs.

In 2023, our own Solectrac anticipates a 2x increase in wholesale sales and a 4x increase in retail sales compared to the previous year.

A robust dealer network is instrumental to growth in the agricultural and utility sectors.

"Dealers are an asset for any manufactured product, as they have a direct connection with the consumer. The relationship dealers have with their customers generates return business and gives the consumer a sense of stability and comfort that would not be received from online sales. Customers can count on dealers for "service after the sale" and Solectrac's network of dealers are ready to serve their customers and those who already bought direct," said Mani Iyer, Chief Executive Officer of Solectrac.

For dealers, adding EV options to their existing product line allows them to offer customers unique products while remaining on the leading edge. Electric vehicles also bring prospective customers to their dealerships who they otherwise may not see.

Customers shopping for an electric tractor can expect a product that functions just as well—if not better—than an equal size diesel unit. Today's generation of Solectrac electric tractors also offers excellent power and perform for up to six hours per charge, depending on application. In addition, electric tractors offer a variety of benefits, including being low maintenance, and free of filters, oil and labor costs.

An economic downturn, coupled with government incentives, creates enticing opportunities for operators to save on fuel costs by switching from diesel to electric.

States like California, Colorado, Oregon, Vermont and New York are increasing government-backed incentives to reduce emissions, accelerating EV adoption. Nationwide, expansive dealer networks like that of Ideanomics's Solectrac, which currently has more than 30 certified dealers, will serve as a valuable consumer entry point to electric tractor education and adoption.

> "The majority of today's customers aren't just looking at the green aspect and the long-term investment, but the monthly payment. Solectrac has four different and highly customizable options for the customer to consider for long-term financing."

MANI IYER

Chief Executive Officer, Solectrac

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In the future, Solectrac customers can also look forward to an expansion of Solectrac's product portfolio, ranging from 25-50 kW compact electric tractors to 50-100 kW utility tractors, addressing up to 80% of the North American and global markets. Electric tractors offer various benefits, including being low maintenance and free of filters, oil and labor costs. Additionally, an electric tractor increases an operator's green footprint with zero emissions and quiet operation, making it the ideal machine for work inside barns, arenas, stadiums and more.

ELECTRIFICATION IN THE FAST LANE: GROWTH IN THE TWO-WHEELER SEGMENT

In the past year, we've seen a significant shift in electric motorcycle demand, as rapid adoption of electric vehicles in the automotive industry has a direct positive impact on the motorcycle market. Initially, the electric motorcycle market was dominated by existing electric motorcycle owners, whereas now, current EV car owners with motorcycle licenses are deciding to go "all-electric". This trend is important, as the convergence of strong and rapidly growing EV adoption, and a substantial proportion of existing internal combustion motorcycle ownership is a strong indicator of marketing potential for electric motorcycle sales.

In the United States, motorcyclists want what car owners want—more range, and a bigger DC fast charging network. New cross-country routes with DC chargers are set no more than 70 miles apart, and Energica's models, including the new Experia, provide the longest range of any electric motorcycle worldwide.

> **"Demand for EVs will increase at a higher rate than the overall automotive or motorcycle markets, despite any economic downturn: the limiting factor is not demand, but the global supply chain."**

LIVIA CEVOLINI
Chief Executive Officer, Energica

The global electric motorcycle and scooter market is valued at $30 billion and is predicted to expand at a 5% compound annual growth rate from 2023 to 2032. Currently, Asia Pacific accounts for 90% of the volume, but larger-displacement of electric motorcycles in the US will see at least a 25% year-over-year growth in 2023 alone.

(Data: BNMEF Outlook 2022)

In 2023 and beyond, we'll see more growth in Japan and Australian markets.

In Japan, 36.2% of all automotive sales today are HEV and the country is aiming for carbon-neutrality by 2050. With 288,150 motorcycles sold in 2021—and 8.2% of the population reporting ownership of a motorcycle or scooter—the push for carbon neutrality will cause an increase in electric motorcycle sales.

(Data: JAMA; JMVA 2021 – Ministry of Internal Affairs, Japan; as of 3/31/22.)

Australia while a smaller market, is on a solid path to electric at 3.4% of all passenger car sales in 2022, enjoying +65% growth in just this year. In 2021, 102,000 motorcycles were sold (+16.6%) the highest in the past 15 years, with over 10% of households now owning one.

(Data: FCAI Federal Chamber of Automotive Industries; Jan. 12, 2022.)

In Europe, governments will continue to adopt the EU policies on carbon-neutrality, setting a leading example by shifting their fleets to electric. The process will be gradual, but Western European countries are already making this commitment, including the electrification of their police fleets.

Two-wheeler technology will find its way into other products in the electric vehicle markets.

Energica Inside combines 10+ years of Energica experience and proprietary technology with a skilled team that offers customized solutions of powertrains, battery packs and systems integrations to EV manufacturers in the agricultural, marine aviation and four-wheeler markets.

Consumers consistently mention two major barriers for EV adoption, that are as true for motorcycles as they are for automobiles: operating range between charges and charging infrastructure. A third consideration, closely following, is price.

Manufacturers, including Energica, have been addressing customer concerns with EV range, knowing that an increase in range encourages more customers to take the leap to electric. Other potential buyers cite wanting to hold out until battery technology allows for even longer ranges and a drop in price. There is a point to this: prices have dropped from $1,000 per KWh in 2010 to $141 per KWh in 2021 and were anticipated to continue dropping. This year however the price has increased by 7%, the first time since 2010; nevertheless, this is within the annual rate of inflation. *(Data: BNMEF Hyperdrive Dec. 9, 2022)*

Research has also shown that within a maximum of three or four years of operation, the total purchase price including cost of ownership between an Energica and a comparable premium internal combustion motorcycle will equalize; and other data for EVs often shows a similar dynamic.

(Data: U.S. Department of Energy Vehicle Cost Calculator https://afdc.energy.gov/calc/)

“Energica’s new Experia electric sport-tourer is ideally suited for authority use thanks to its long highway range, excellent all-weather protection, and extraordinary maneuverability even at low speeds in urban congestion. This highly desirable combination of attributes has always been the mission for electric motorcycles.”

LIVIA CEVOLINI
Chief Executive Officer, Energica

The greatest need is for the coalition between government, utilities and charging companies to be augmented to improve the network of stations, but critically, address reliability of the existing network, as this is the main area of discontent by existing EV owners.

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BUILDING TOMORROW'S EV SOLUTIONS, TODAY

“Incentives from the federal government, combined with state incentive programs, will help negate adverse impacts on specialty vehicle purchases during an economic downturn. Lowering our carbon footprint and pumping the breaks on climate change is a worldwide concern. Climate change doesn't care about a recession, and as technology continues to improve the demand will grow.”

MACY NESHATI

Chief Commercial Officer, Ideanomics

For specialty vehicle manufacturers such as Ideanomics's US Hybrid, advancements in battery technology will address customer demands for EV range that matches its internal combustion engine (ICE) counterparts in coming years. In the past, that requirement has been challenging to comply with in battery electric retrofits. However, rapidly evolving battery technology will help close the range gap in 2023 and be equal to ICE counterparts in 2024.

While hydrogen retrofits solve the range issue, these specialized retrofits are more expensive, and the fuel stations are not as plentiful as battery charging stations. Even so, we can expect advances in hydrogen production technology in 2023 and 2024 that could change the landscape and increase adoption.

Trends and opportunities for retrofitting vehicles

In addition to matching the range of the ICE vehicles they are replacing; customers also expect retrofitted vehicles to be cost-efficient over the lifecycle. At US Hybrid, we expect our vehicle performance to be as good, or better, than the original ICE system.

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BUILDING TOMORROW'S EV SOLUTIONS, TODAY

Market outlook: Retrofitting specialty vehicles amidst shifting economic conditions

US Hybrid is also seeing strong interest and growth potential on multiple fronts including ports, transit and sweeper OEMs, as well as potential in the South American market.

Advancing zero-emission solutions in the specialty vehicle market takes a great deal of coalition building. It's always good to have the local utility company involved early on, as well as the agencies that regulate air quality.

"Climate change action will continue to accelerate specialty electric vehicle demand, especially in markets with chronic air quality problems. From citizen and community involvement to local utility companies to government agencies and legislators, advancing zero-emission solutions in the specialty vehicle market will require action at every level. In California, we have great relationships with the Coalition for Clean Air and the Sierra Club as two examples," said Macy Neshati, Chief Commercial Officer of Ideanomics.

"We are excited about 2023, we think our top line number is around $26 million with 90% coming from specialty vehicles and the balance from our power electronics business."

MACY NESHATI

Chief Commercial Officer, Ideanomics

SUCCESS STORY: ELECTRIFYING AVTA

Antelope Valley Transit Authority (AVTA) in Lancaster, California, converted their entire fleet of local transit buses from diesel to battery electric using state and federal grants to pay the capital costs. In 2021 thru savings in fuel expense, reduced maintenance expense and reduced hazardous waste hauling expense, they went from an average of spending over $1.30 per mile traveled per bus to earning over .20¢ per mile after earning (Low Carbon Fuel Standard) credits from the state of California.

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BUILDING TOMORROW'S EV SOLUTIONS, TODAY

Determining which solution is right for specialty vehicles

Electrification will become an interactive process with the customer, rather than a one-size-fits-all solution. Hydrogen retrofits will also extend product lifecycles for transit buses, medium and heavy-duty trucks and large container handling equipment in ports, railyards and warehouses.

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