

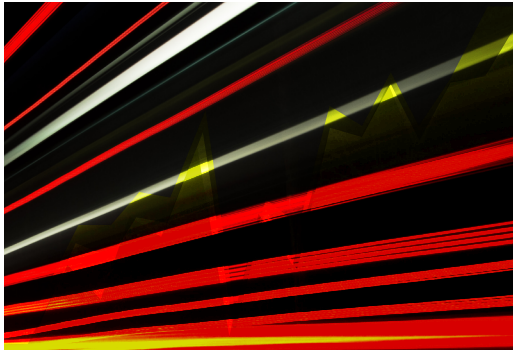


**OFF-HIGHWAY
VEHICLES SURGING
IN ELECTRIFICATION
PRACTICES**

EQUIPMENT MARKET OUTLOOK ON-THE-GO



APRIL 2019



U.S. Construction Machinery New Orders during the 12 months through January were up 5.8% from 1 year ago; exports increased in 2018 but fourth quarter numbers represent slowing growth in demand from abroad. Annual total U.S. Farm Machinery and Equipment Supplies rose 17.8% in January from the previous year, however are now in a slowing growth trend.

Annual average Europe Agriculture Machinery Production has generally moved lower in recent months although Production in January came in 1.8% above the year-ago level. The Europe Leading Indicator trend suggests business cycle decline (slowing growth or contraction) in Europe Industrial Production will extend into at least the fourth quarter of 2019. |

Annual average Europe Agriculture Machinery Production has generally moved lower in recent months although Production in January came in 1.8% above the year-ago level. The Europe Leading Indicator trend suggests business cycle decline (slowing growth or contraction) in Europe Industrial Production will extend into at least the fourth quarter of 2019. |

Go to oemoffhighway.com to sign up for our monthly ECONOMIC NEWSLETTER!

QUESTIONS?
economics@oemoffhighway.com

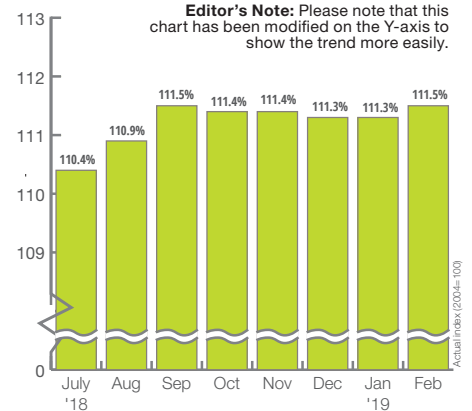


ITR Economics is an independent economic research and consulting firm with 60+ years of experience.

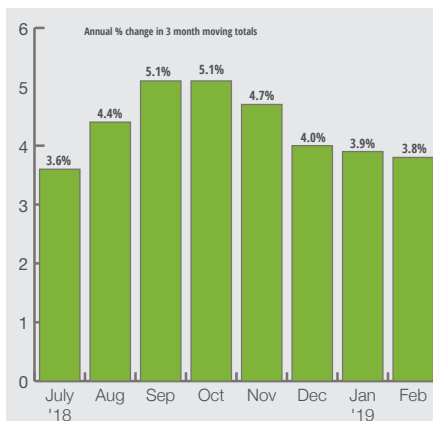


U.S. Leading Indicator:

- The Conference Board's U.S. Leading Indicator ticked up in February. The monthly rate-of-change is declining off a tentative September 2018 peak.
- The September peak in the Indicator rate-of-change suggests that U.S. Industrial Production could transition to a slowing growth trend around the second quarter of 2019, given the typical lead time between changes in the Indicator and Production.



U.S. Industrial Production:

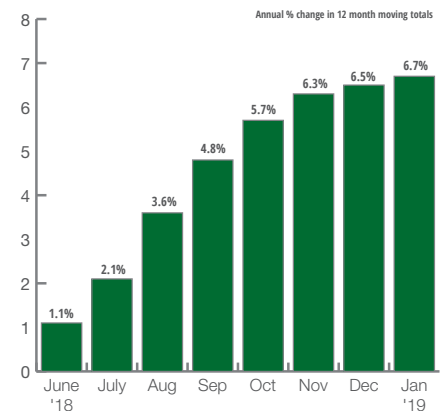


- Average Production during the 3 months through February was 3.8% above the same 3 months 1 year ago. The quarterly rate-of-change has edged downward for the last 5 months.
- Movements in the Institute for Supply Management's PMI suggest rate-of-change descent in quarterly U.S. Industrial Production will likely persist for at least the next two quarters.



U.S. Total Public New Construction:

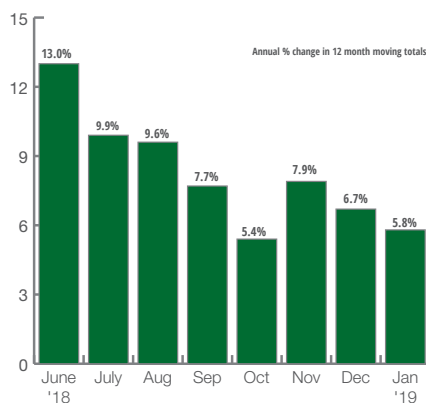
- Annual U.S. Total Public New Construction in January was \$303.0 billion, up 6.7% year over year. Construction is in an accelerating growth trend.
- The decline in U.S. Municipal Bond Issuance in late 2018 suggests that the accelerating growth trend in Construction is likely to be short lived.





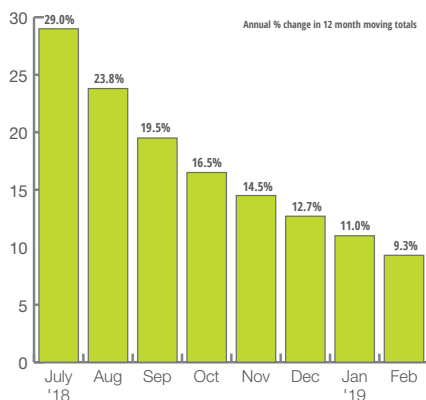
U.S. Construction Machinery, New Orders:

- U.S. Construction Machinery New Orders totaled \$35.8 billion during the 12 months through January, up 5.8% from 1 year ago. The annual total is stagnating.
- U.S. Exports of Construction Machinery were up 16.1% in 2018 versus the 2017 total. However, fourth-quarter Exports were up a mere 1.4% relative to the fourth quarter of 2017. This could be representative of slowing growth in demand from abroad.

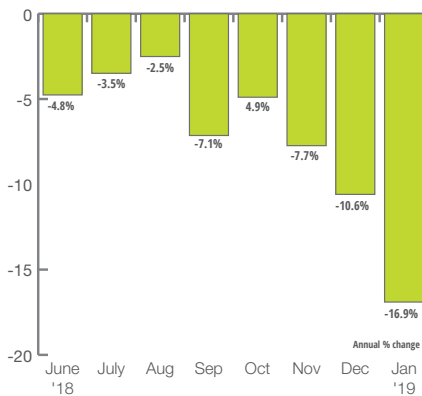


North American Rotary Rig Count:

- The North American Rotary Rig Count averaged 1,242 rigs during the 12 months through February, one rig shy of the January annual average but 9.3% above the year-ago level of 1,137 rigs.
- Trends in the ITR Leading Indicator™ suggest rate-of-change descent in the Rig Count will likely persist through at least 2019.



China Diesel Bus Production:

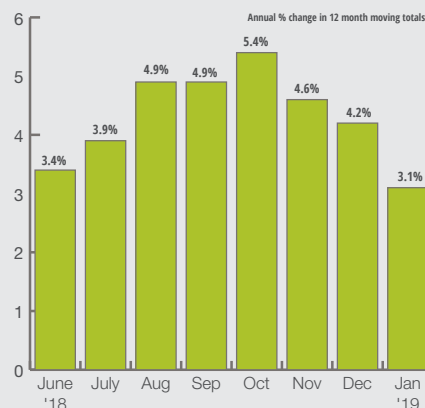


- The China Large Diesel Bus Production annual rate-of-change dipped lower to -16.9% in January.
- Trends in China Automobile-Related Instruments and Meters Production, a four-month leading indicator to Bus Production, suggest decline in the Bus Production annual rate-of-change will likely extend into at least the second quarter of 2019.

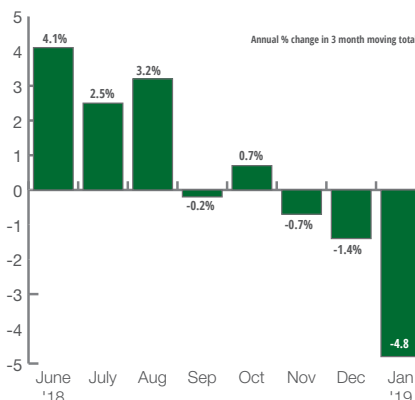


U.S. Private Nonresidential New Construction:

- U.S. Private Nonresidential New Construction during the 3 months through January totaled \$110.3 billion, up 3.1% from the same time 1 year ago. The quarterly rate-of-change moved lower during the last 3 months.
- Accelerating rise in U.S. Real Gross Domestic Product bodes well for Nonresidential Construction into the second half of the year and indicates that the Construction quarterly rate-of-change could resume rising.



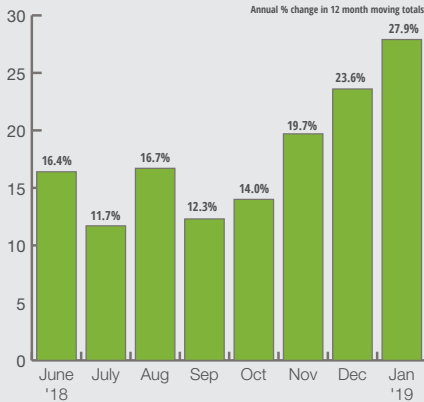
Germany Industrial Production:



- Average Germany Industrial Production during the 3 months through January was 4.8% lower than the same 3 months 1 year ago.
- The Germany Purchasing Managers Index for Manufacturing indicates that the Production quarterly rate-of-change could decline further into at least the fourth quarter of the year.



U.S. Defense Industry, New Orders:



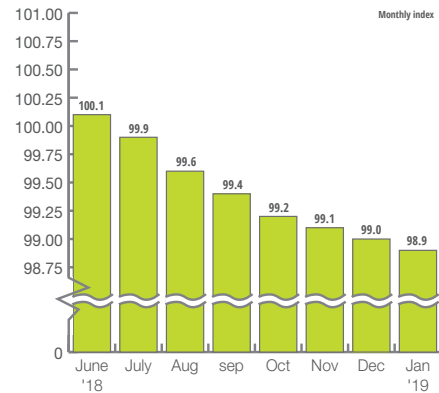
- U.S. Defense Capital Goods New Orders in the 12 months through January totaled \$154.5 billion, a record high level. New Orders are rising at the fastest pace (27.9% year over year) in nearly 8 years.
- Leading indicator evidence signals that the accelerating growth trend will likely give way to slowing growth in the coming months.



Editor's Note:
Please note that this chart has been modified on the Y-axis to show the trend more easily.

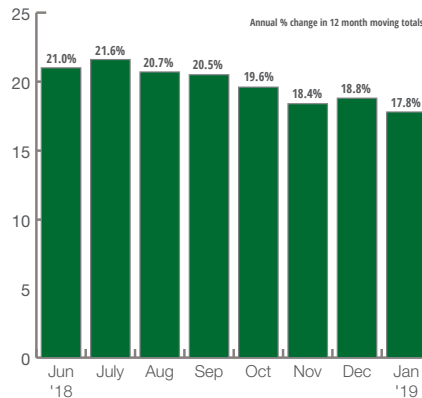
Europe Leading Indicator:

- The Europe Leading Indicator moved lower in January. However, the rate-of-change, at -2.0% in December and January, is moving sideways. More data is needed to determine if this is just volatility or if a trough is forming.
- The Indicator trend suggests business cycle decline (slowing growth or contraction) in Europe Industrial Production will extend into at least the fourth quarter of 2019.



U.S. Farm Machinery Production:

- Annual total U.S. Farm Machinery and Equipment Supplies rose to \$30.9 billion in January, up 17.8% from 1 year ago. Farm Machinery and Equipment Supplies are in a slowing growth trend.
- Trends in quarterly Food Product Shipments, which are nearly flat with the year-ago level, indicate that the Farm Machinery and Equipment Supplies annual growth rate is likely to continue to move downward in at least the near term.

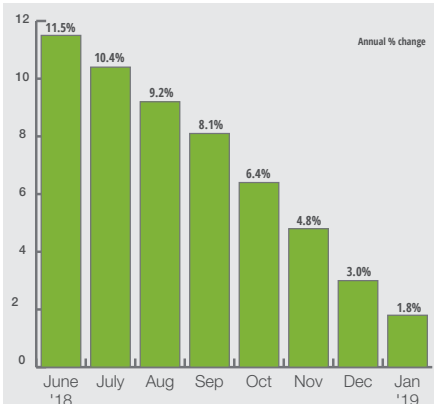


U.S. Heavy-Duty Truck Shipments:

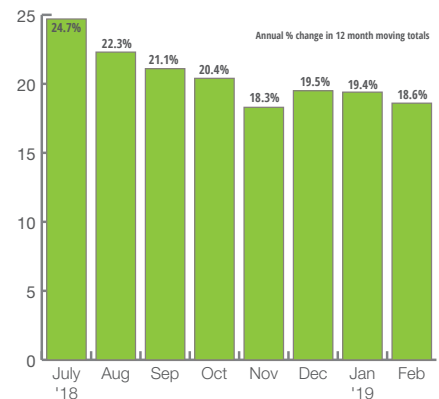
- Annual average U.S. Heavy-Duty Truck Production through February was 18.6% above the year-ago level. Production is at the highest level since early 2007.
- Robust growth in U.S. Heavy-Duty Truck Retail Sales, up 31.0% year over year, signals further growth in Production is likely in at least the coming quarters.



Europe Ag & Forestry Machinery Production:



- Annual average Europe Agriculture Machinery Production has generally moved lower in recent months from a tentative September peak. Despite the recent decline, annual average Production in January came in 1.8% above the year-ago level.
- Europe Food Production trends point to the likelihood of at least six more months of decline in Agriculture Machinery Production.



OFF-HIGHWAY VEHICLES SURGING IN ELECTRIFICATION PRACTICES



WHILE ELECTRIFIED VEHICLE TECHNOLOGIES MAY BE MORE WIDELY INTEGRATED IN THE ON-HIGHWAY VEHICLE MARKET, OFF-HIGHWAY EQUIPMENT IS FULLY COMMITTED TO THE TECHNOLOGY'S DEVELOPMENT.

It's no secret that the heavy-duty off-road equipment market lags in new technology integration behind automotive and on-highway vehicle development. However, with the high overhead per vehicle in industries like construction, agriculture and mining, the faster a vehicle's cost can go from long-term investment to revenue-generator, the better.

With advancements in on-board electronics and smart systems, the electrification space is helping to create more productive, easier to use, and safer vehicles for an industry that is seeing a serious decline in its skilled labor force. *Read, [A Closer Look at Benefits of Electrification in Heavy-Duty Equipment](#), as Waytek investigates the top five benefits of electric-powered systems.*

In a recent survey conducted by Waytek in partnership with OEM Off-Highway, “[the pursuit of] electric heavy-duty equipment promises long-term cost savings because of less maintenance, fewer moving parts and of course, less fuel consumption.”

When it comes to off-highway heavy-duty vehicle applications, another consideration is the duty-cycle and its significant distinction from on-highway uses. Trucks and buses are typically doing long distances at more

⬆️ Powered by Cummins BM4.4E flexible battery modules, the 3.5-ton Hyundai excavator prototype is designed to support a full work shift and charge in under 3 hours.

constant power draws. These vehicles can utilize slow-energy discharging batteries that recharge during braking sessions using regenerative braking technology, or charge overnight during travel downtime. The trucking industry, for example, has limits to how long a vehicle can be continuously operated for driver's safety, whereas construction equipment is used in shifts by multiple operators and may see very little downtime.

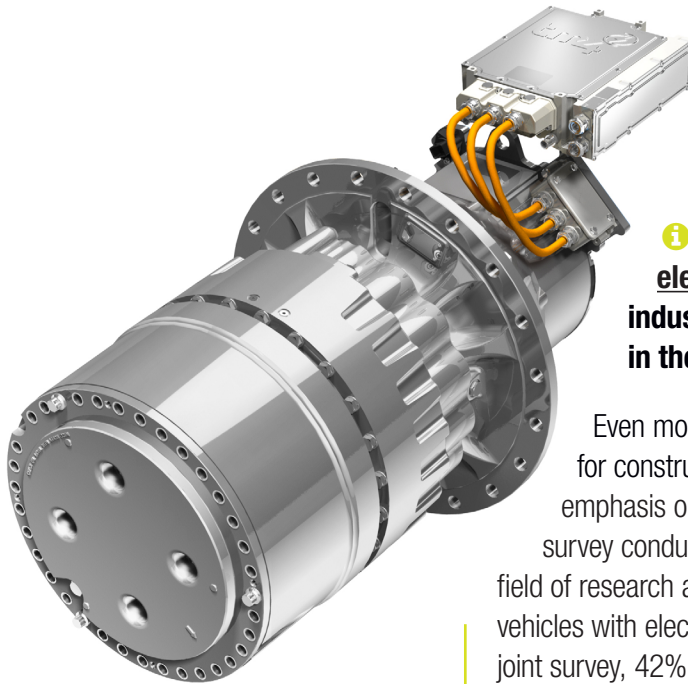
In the off-highway vehicle space, equipment like an excavator on a construction site will have high power draws frequently while raising and lowering the boom and bucket for digging operations, for example. While there are examples of excavators using regenerative technologies during boom lowering and storing reclaimed energy in a hydraulic accumulator, there are relatively few examples of electric power being utilized in larger equipment sizes. The first opportunity for electric-power applications is in the smaller, compact vehicle space with lower power demands.

As is noted in the [survey results](#) from Waytek, 32% of respondents think that battery power is the greatest challenge electrification usage and acceptance faces in off-highway vehicle applications. And beyond the battery technology limitations itself, an established infrastructure for producing, disposing of/recycling, and charging the battery technology is an additional layer of complication and industry development necessary for electrification to be met with enthusiasm instead of skepticism by industry professionals and manufacturers.

But, beyond the challenges the electrification trend faces, there are huge bright spots as component manufacturers and system suppliers invest heavily in electric system development. Companies such as Dana, AxleTech, Meritor, ZF and Comer have recently demonstrated their commitment to electrification with acquisitions, joint development projects with OEMs, and product launches.

✔ Mecalac's e12 features two independently operating electric motors, one powering the excavation mechanism and one for movement.





i Head to www.OEMOffHighway.com/trends/electrification for all of the latest relevant industry news and product announcements in the electrification market space.

Even more recently, at bauma 2019, the world's largest tradeshow for construction and mining industries, there was a significant emphasis on the electric drive and related technologies. In a survey conducted by show organizer Messe Munchen, the largest field of research and development at 32% was "development or use of vehicles with electric drives." Within the Waytek and OEM Off-Highway joint survey, 42% of its respondents said their companies will be taking steps or continuing to pursue electrification in the next 12 months.

Dana recently acquired TM4, Oerlikon Drive Systems, Brevini and SME Group with the clear goal of enhancing its electromobility and e-Drive product offerings. The Spicer Electrified with TM4 e-Hub Drive is a fully integrated electro-mechanical system combining Dana's heavy-duty Spicer axle expertise, Brevini planetary drive designs, TM4 electric motor technology and advanced control expertise into a single package.

Electrification trends coupled with the inevitable pursuit of fully-autonomous vehicles has paved the way for a massive surge in interest, investment and innovation surrounding cleaner, safer, quieter and more productive equipment. As battery technology advances, shrinks and comes down in cost, you will see more and more OEMs and system manufacturers start releasing commercially viable system solutions.

It's not a matter of if the electric age will arrive, it is only a matter of when. And for some manufacturers, that timeline is shorter than many will be able to competitively meet.

➤ The housing for an internal combustion engine now incorporates LiFePO₄ battery technology for the Mecalac e12. Iron and phosphate (Fe and P) offer three times as many charge cycles as classic batteries with no risk of fires or battery fluid leaks.



✔ A record capacity of 146 kWh can be installed, which results in a range of 8 hours of production.

But, while there are still immense hurdles for off-highway equipment to leverage electric power to its fullest potential, as one survey respondent pointed out, “I believe the future of electrification is dependent upon the proper application of electric equipment rather than the wholesale push, which always ends in failure.” This calls to attention a key clarification: Electric power may never overtake the entire off-highway industry, but rather only prove beneficial to specific applications. Applications such as underground mining equipment where the emissions elimination would be essential to miners, compact construction equipment used in residential

and municipal sites, and agricultural equipment where the owner/operator sees long-term investment benefits and revenue directly into his or her bottom-line. ■



i Read the full report, **“The State of Electrification in Off-Road and Heavy-Duty Equipment,”** based on the results of the survey conducted by Waytek in collaboration with OEM Off-Highway.

i Recent developments in electrification from the off-highway vehicle industry:

Dana Collaborates with Mecalac to Provide e-Drivetrain for Electric Compact Wheeled Excavator

TOBROCO-GIANT Presenting Fully-Electric Loaders at bauma 2019

Cummins-Powered Electric Mini Excavator Prototype to be Exhibited at bauma 2019

ZF to Demonstrate Construction Site of the Future at bauma 2019

Hidromek to Exhibit New Electric Excavator at bauma 2019

INPOWER OFF-ROAD LOAD MANAGEMENT

ELECTRIFICATION SOLUTIONS FOR WORK TRUCKS



When you need long-lasting, dependable products look no further than InPower's line of solid state work truck electrical system solutions.

InPOWER
the systems people

ABS - AUXILIARY BATTERY SWITCHES



- Efficient, reliable, low heat operation
- Isolates chassis battery from excessive discharge to auxiliary battery and loads

LOW VOLTAGE DISCONNECTS



- Fully automatic
- Disconnects auxiliary loads at predetermined setting

DBT - HIGH IDLE THROTTLES



- Cost effective with easy, fast installation
- Data Bus controlled with pass-through OBD-II connector supplied

Checkout our white paper on Electrification at www.waytekwire.com/electrification



To view stock, check pricing, or to place your next order visit:

WAYTEKWIRE.COM/INPOWER

waytekwire.com | P: 800-328-2724 | E: sales@waytekwire.com