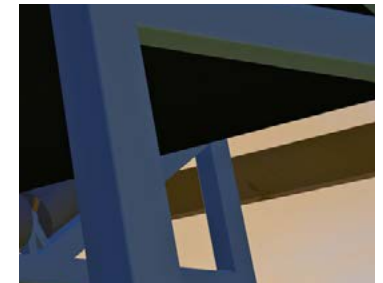
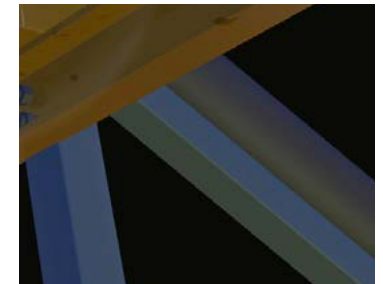


A photograph of two workers in dark uniforms and yellow hard hats standing in a futuristic, brightly lit tunnel. The tunnel's interior is composed of curved, glowing orange and yellow structural elements that create a sense of depth and perspective. The workers are silhouetted against the bright light at the end of the tunnel. The floor is highly reflective, mirroring the workers and the tunnel's structure. The overall atmosphere is one of advanced technology and industrial innovation.

ENERGY 2020 VISION: OIL & GAS

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EXECUTIVE SUMMARY



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Ready or not, the global oil & gas industry must contend with an ever-changing 'normal'.

The oil price collapse in late 2014 signified a fundamental change in the energy marketplace. While prices have rebounded from the low of \$26 per barrel in 2016, the supply and demand dynamics that led to the downturn—a supply glut due in large part to U.S. shale and stagnating growth in global demand—are here to stay. Efforts to rebalance the markets have helped inventory levels recover, but those efforts are contingent on key producers limiting output. Gone are the days when success was linked almost exclusively to high production volumes and growing reserves.

It's the confluence of trends—not just the new pricing paradigm, but rapid growth in renewables along with accelerating technology advancements—that is reshaping the industry. The energy company of the future is one that has successfully figured out how to cut costs, enhance operational efficiencies through digital and

technological transformation, and diversify its portfolio to include alternative energy sources.

Reflecting on this period of turmoil and transition, BDO's Global Natural Resources team is looking towards the future to help oil & gas companies anticipate and plan for the challenges and opportunities ahead. We believe that to prepare for success in 2020 and beyond, oil & gas companies must strive to become "Lean, Green, Digital" machines.

The global predictions presented in this report are based on research and collective input from BDO's Natural Resources leaders around the world. In addition, the practice leaders from five countries (Australia, Canada, the United States, the United Kingdom, and the Kingdom of Saudi Arabia) have provided regional predictions for the industry in their markets.

SUMMARIZING BDO'S GLOBAL ENERGY 2020 VISION FOR OIL & GAS:

1. OIL PRICES:

By 2020, low oil prices—expected to remain at or below the \$60 per barrel mark—will spur Gulf Cooperation Council countries to diversify their energy mix within the power sector using auctions to subsidize renewable energy projects.

2. CYBERSECURITY:

By 2020, at least five countries will see foreign hackers take all or part of their national energy grid offline through Permanent Denial of Service attacks.

3. GLOBAL ENERGY TRADE:

By 2020, the growth of LNG imports and solar power will bring electricity to four in five African people.

4. INVESTMENT IN TECH:

While overall spending on R&D may decline, most of the spending that does occur will go towards technologies that enhance exploration and production (E&P) efficiencies.

5. DATA DEMOCRATISATION:

By 2020, the average E&P company will make use of 10 percent of its big data—up significantly from today, but nowhere near full potential.

Agree or disagree with our predictions? We want to know — reach out to us [here](#).

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BDO'S ENERGY 2020 VISION: THE NEAR FUTURE OF OIL & GAS *GLOBAL PREDICTIONS*



GULF COUNTRIES DIVERSIFY WITH WIND AND SOLAR

PREDICTION 1

OIL PRICES

BY 2020, LOW OIL PRICES—EXPECTED TO REMAIN AT OR BELOW THE \$60 PER BARREL MARK—WILL SPUR GULF COOPERATION COUNCIL (GCC) COUNTRIES TO DIVERSIFY THEIR ENERGY MIX WITHIN THE POWER SECTOR, USING AUCTIONS TO SUBSIDISE RENEWABLE ENERGY PROJECTS.

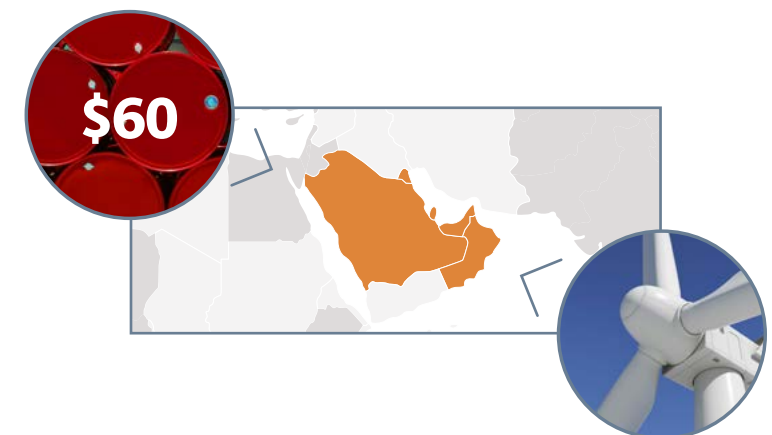
The pressure is on for GCC countries—Saudi Arabia, Kuwait, the United Arab Emirates, Qatar, Bahrain, and Oman—to diversify away from oil, especially when it comes to electricity production.

The rising domestic demand for oil, especially in the power sector, is hindering the GCC countries' ability to export oil and causing their economies to contract. In [October 2017](#), the International Monetary Fund (IMF) cut the 2018 GDP forecasts for the GCC states from 2.5 percent to 2.2 percent. Non-oil related economic growth is expected to reach 2.4 percent in 2018—well below the 6.7 percent average seen from 2000-2015. Oil-exporting countries across the broader region saw their fiscal deficits skyrocket from 1.1 percent of GDP in 2014 to 10.6 percent of GDP last year.

GCC countries' current trajectory is unsustainable. Most have already begun importing LNG because of the shortage in cheap natural gas, further underlining the need for efficient, non-hydrocarbon energy

sources in the area. Countries are starting to make renewables realistic through auction-based approaches to subsidies. Through auctions, countries set a target level of investment in renewables and allocate contracts to the most cost-effective bidders. Almost 50 countries have adopted [this approach](#), and almost 30 additional countries are considering following suit.

Although GCC countries have set targets for deployment of renewables at the national or local level, the region has seen [little deployment](#). By 2020, we predict that relatively low oil prices will spur GCC countries to diversify their energy mix within the [power sector](#). As utility-scale installed solar and wind costs continue to decline, they will use [renewable energy auctions](#) to begin reaching their deployment targets.



ATTACK AGAINST THE GRID: A DRESS REHEARSAL FOR WHAT'S TO COME?

PREDICTION 2

CYBERSECURITY

BY 2020, AT LEAST FIVE COUNTRIES WILL SEE FOREIGN HACKERS TAKE ALL OR PART OF THEIR NATIONAL ENERGY GRID OFFLINE THROUGH PERMANENT DENIAL OF SERVICE (PDOS) ATTACKS.



The advances in technology that allow the energy industry to create new efficiencies and innovations at the same time require connectivity that leaves power grids around the world more vulnerable to cyberattacks.

Several electric grids around the world have already come under threat in recent years, most through Distributed Denial of Service (DDoS) attacks. In 2015, [an attack](#) on a grid in the Ukraine temporarily cut power to more than 200,000 people. A subsequent attack occurred just a year later, reportedly carried out by Russian actors. In May 2017, officials from the Baltic states—which are connected to Russia's power network but plan to move to the European Union's grids—said their power grids were targeted by Russia through a series of DDoS attacks. "On a daily basis there are DDoS attacks designed to probe network architecture, so it could well be possible that something (serious) could take place later on," a NATO official told [Reuters](#).

Any disruption to a country's electric grid would have serious implications for virtually all industries, especially critical ones like healthcare, transportation, security, and financial services. Since 2011, a dedicated and sophisticated group of cyber attackers known as [Dragonfly](#) has been targeting the energy sector in Europe and North America. The group has used Trojanised software, spear phishing emails and watering hole websites to gather intelligence with the potential for sabotage.

While the number of total DDoS attacks decreased by [18 percent year-over-year in Q2 2017](#), there was a 19 percent increase in the average number of attacks per target. This could indicate that the quantity of DDoS attacks may be waning, but the severity of each attack is increasing.

WE PREDICT THAT TODAY'S ATTACKS ON THE GRID ARE A DRESS REHEARSAL FOR A MUCH MORE MALICIOUS TYPE OF ATTACK: PDOS. BY 2020, AT LEAST FIVE COUNTRIES WILL SEE FOREIGN HACKERS TAKE ALL OR PART OF THEIR ENERGY GRID OFFLINE WITH THE INTENT TO DESTROY IT.

LNG & SOLAR: THE PAIR THAT COULD FLIP THE SWITCH IN AFRICA

PREDICTION 3

GLOBAL ENERGY TRADE

BY 2020, THE GROWTH OF LNG IMPORTS AND SOLAR POWER WILL BRING ELECTRICITY TO 4 IN 5 AFRICAN PEOPLE.

Africa represents 16 percent of the world's population but just 32 percent, or 1.5 in 5 African people, have access to electricity. The growth of liquefied natural gas (LNG) could change that.

While [many governments in Africa, especially in sub-Saharan Africa](#), have intensified efforts to invest in domestic energy production, inadequate energy infrastructure has stood in their way. Two out of every three dollars invested into the sub-Saharan energy sector since 2000 have been used to develop energy to be exported rather than for local consumption.

LNG expansion is forecast to help natural gas demand outpace demand for oil and coal [through 2040](#). Africa presents an opportunity for LNG producers to find new sources of demand.

Electricity in Africa has remained expensive—a particularly difficult barrier for its population. However, as noted by the [Africa Energy Outlook](#), “huge renewable resources remain untapped,” with further potential from excellent solar capabilities across all of Africa. Foreign solar companies have taken notice and have [installed solar microgrids](#) or home-based solar systems across sub-Saharan Africa. At the same time, African countries have begun building import facilities for LNG, including a facility in [Ghana](#)—the first import facility in the sub-Saharan market. The continued growth in solar power across Africa could improve the wider energy infrastructure, creating a ripple effect and attracting foreign LNG exporters to invest in pipeline construction, a further boon to their business.

Renewable energy has begun to help more Africans turn and keep the lights on, and LNG exporters—and their investors—will follow this initial track. By 2020, we predict that the growth of LNG imports and solar power within Africa will bring electricity to four in five people on the continent.



INVESTING IN TECH TO KEEP THE LIGHTS ON

PREDICTION 4

INVESTMENT IN TECH

WHILE OVERALL SPENDING ON R&D MAY DECLINE, MOST OF THE SPENDING THAT DOES OCCUR WILL GO TOWARDS TECHNOLOGIES THAT ENHANCE EXPLORATION AND PRODUCTION (E&P) EFFICIENCIES.

As downward pricing pressures rage and with much of the world's [easy-to-reach oil](#) already consumed, oil & gas companies are tasked with producing more with less—or risk shutting their doors. To accomplish this, energy companies, historically slow to do so, are investing in new technologies to increase operational leanness while boosting profit margins.

Technology is present throughout the energy supply chain, from locating oil wells and extracting reserves to refining and transporting the commodity. Oilfield services companies like [Halliburton](#) and [Schlumberger](#) note that their customers already use high-tech equipment and data analytics to determine whether a well will produce enough oil to make it economic—before the drilling begins. Others are using more advanced technologies to “refrack” wells originally drilled using less advanced technologies to extend their shelf life and further capitalise on them. When it comes to new wells, engineers use software and sensor technology to determine the right combinations of chemicals, sand, and water to maximise extraction. When deciding where to drill, E&P companies already rely on a combination of Monte Carlo simulations and 3D seismic surveys to generate 4D seismic imaging and project future physical changes to the oilfield and reservoir. Using current technology, the industry has about an 80 percent overall drilling success rate.

While oil & gas companies have in the past been labelled “[low R&D intensity](#),” investing less than 1 percent of net revenue in R&D, spending on innovation and R&D has increased notably over the last few years.

Investing in innovation is the first step towards global oil & gas companies reducing expenditures while maximising production and maintaining margins. By 2020, while their overall R&D spending may decline, oil & gas companies will put most of their remaining dollars into technologies that boost E&P efficiencies in an effort to do more with less.



A large offshore oil rig stands in the ocean under a sunset sky. The rig's complex metal structure is silhouetted against the orange and blue hues of the setting sun. The water in the foreground is dark blue with gentle ripples.

DEMOCRATISATION OF DATA

PREDICTION 5

DIPPING INTO THE DATA

BY 2020, THE AVERAGE E&P COMPANY WILL MAKE USE OF 10 PERCENT OF ITS BIG DATA—UP SIGNIFICANTLY FROM TODAY, BUT NOWHERE NEAR FULL POTENTIAL.

As the adoption of new technologies quickens, the upstream sector's access to data will grow exponentially. Under the pressure of subdued oil prices, the ability to tap into that data becomes a lifeline.

Upstream companies place tens of thousands of data-collecting sensors within wells and surface facilities to monitor assets and environmental conditions in real time. When used correctly, data can create efficiencies across the entire E&P process—from locating and extracting hydrocarbon to arranging for delivery to trucks and pipelines for transport and refinement. In the discovery stage, E&P companies can use [data analytics](#) to analyse year-on-year geological survey data to determine the best places to drill. During the drilling phase, drill bit and

rig technology can track progress continuously and create more accurate and safer drilling processes. When it comes to extraction, data can be analysed to conduct predictive maintenance on wells and determine whether certain wells should be re-fracked.

While most E&P companies have adopted new technologies, they still lack the data analytics capabilities needed to extract the [maximum value of that data](#). Upstream companies are often unable to integrate different sources of data, and information gathered from different datasets is left in silos, unavailable to decision-makers who need it most. Technology companies providing the data infrastructure are often unaware of how to apply the analytics tools to the oil

industry effectively. As a result, most data collected from upstream operations, while it may be used for issue detection and control, is never used for performance optimisation. The average offshore rig has 30,000 data-generating sensors, but [less than 1 percent](#) of that data is analysed and used in decision-making.

As tech companies begin to partner more with the E&P sector, we expect innovation to accelerate and better data integration across organisations to take shape. By 2020, we predict the average E&P company will make significant strides towards data democratisation, making use of 10 percent of its big data—up notably from today, but still nowhere near full potential.

BDO'S ENERGY 2020 VISION: THE NEAR FUTURE OF US OIL & GAS





LNG: THE US'S FOR THE TAKING?

PREDICTION 1

GLOBAL ENERGY TRADE

BY 2020, 30 PERCENT OF LIQUEFIED NATURAL GAS (LNG) EXPORT CAPACITY WILL BE BUILT IN THE US, MAKING IT ONE OF THE LARGEST GAS EXPORTERS IN THE WORLD.

As the largest global natural gas producer, the US is already a force to be reckoned with in the international energy trade. The nation's market share will continue to accelerate leading [up to 2020](#), buoyed by active shale drilling, and LNG is a pivotal element of our projected growth trajectory. By 2020, the US will be one of the largest gas exporters in the world, accounting for 30 percent of LNG export capacity.

Forecasts from the US Energy Information Administration (EIA) peg LNG exports at [2.8 billion cubic feet per day in 2018](#) – more than five times 2016 quantities when the first LNG shipment left US shores. The marriage of established infrastructure, inexpensive production costs, and regional stability equip the US with a strong foothold in the market.

Qatar and Australia currently hold the titles as the number one and number two LNG exporters, respectively, but the US is uniquely positioned to emerge as another global LNG leader. While well-positioned geographically to reach the Asian market, Australia is at the same time saddled with the costly task of strengthening infrastructure. In Qatar's case, the blockade imposed by Saudi Arabia, the UAE, Egypt, and Bahrain dominated headlines this year. While it is likely that the Qatar-Gulf crisis will reach a resolution ahead of 2020, turmoil is an unfortunate constant in the Middle East, dampening Qatar's long-term potential to be an LNG leader.

Asian markets will be a key source of demand for US LNG in 2020. The European Union and the United Kingdom will also be prime markets for US LNG, as they move to lessen their dependency on Russian gas in favor of a more reliable, consistently priced LNG supplier.

US POWER GRID: A CYBERCRIMINAL'S HOLY GRAIL

PREDICTION 2

CYBERSECURITY

THE US NATIONAL ELECTRIC GRID WILL BE THE TARGET OF A PERMANENT DENIAL OF SERVICE ATTACK (PDOS) BY 2020.

The US national energy grid hasn't fallen victim to a cyberattack yet, but its days are numbered. At the time it was constructed, physical—not cyber—security was the key priority, opening the grid up to vulnerabilities. Ukraine and Finland's power grids were recent targets of Distributed Denial of Service (DDoS) attacks, causing a temporary disruption to services or operations.

By 2020, we expect the US critical infrastructure will be the victim of an even nastier strain of cyberattacks—permanent denial of service (PDOS). True to its name, PDOS attacks aim for permanent destruction and can manifest in three key ways: Destroying physical equipment and structures, disabling services and/or wiping out data.

With increasing success since 2011, a sophisticated group of cyber hackers called Dragonfly have used Trojan-horse software, ransomware, and targeted spear-phishing attacks on energy facilities and executives to gain access to critical information systems and operational databases, potentially laying the groundwork for

a larger-scale attack like PDOS.

As one of the largest and most sophisticated economies, an attack to the US's power grid is the holy grail for cybercriminals. Cyberwarfare is a worsening national security threat, and the US energy industry is a likely battleground for early attacks.

The power sector isn't the only slice of the energy industry with a target on its back. A cyberattack to the nation's pipelines—targeting a key junction so fuel can't flow through—could disrupt oil exports and domestic supply. Cyber vulnerabilities extend throughout the oil & gas supply chain, impacting all companies from exploration and production (E&P) to oilfield services (OFS).





TO DRILL OR NOT TO DRILL: TECH ELIMINATES THE QUESTION

PREDICTION 3

TECHNOLOGY

DIGITIZATION AND TECHNOLOGICAL ADVANCEMENTS—THE NEXT GENERATION OF SEISMIC IMAGING AND PREDICTIVE ANALYTICS—WILL NEARLY ELIMINATE EXPLORATION RISK FOR OIL & GAS DRILLING AND WILL PROPEL THE US INDUSTRY TO ACHIEVE A DRILLING SUCCESS RATE BETWEEN 95 TO 100 PERCENT.

The energy industry may power the world, but technology is the force fueling the oil & gas sector behind the scenes. Technology is present throughout the energy supply chain, from locating oil wells and extracting reserves to refining and transporting the commodity. With the acute understanding that advanced technology increases operational leanness and profit margins, energy companies have always been early-adopters of technology.

A recent [partnership](#) forged between oilfield service company (OFS) Halliburton and Microsoft offers a preview of the digital transformation ahead for oil & gas. The pair teamed up to collaborate on bringing

machine learning, augmented and virtual reality, cloud software solutions, and the Industrial Internet of Things (IIoT) to the oilfield.

Which stages of exploration and production are on the verge of a digital revolution? Continued innovation will lead to greater precision and accuracy during crucial decision-making junctures, including the first core decision: to drill, or not to drill. Today, E&P companies rely on a combination of Monte Carlo simulations and 3D seismic surveys to generate 4D seismic imaging and project future physical changes to the oilfield and reservoir. Using current technology, the industry has about an 80 percent overall

drilling success rate. By 2020, US oil & gas companies will have achieved a success rate between 95 to 100 percent for locating and assessing oil reserves, eliminating a key risk in the exploration process.

Oil & gas companies have worked tirelessly to [harness technology](#) in recent years, but today's cutting-edge advancements are only the beginning. Technology is an untapped oilfield, primed for exploration.

UP FOR DEBATE: US PIPELINE TO CENTRAL AMERICA

PREDICTION 4

ENERGY INFRASTRUCTURE:

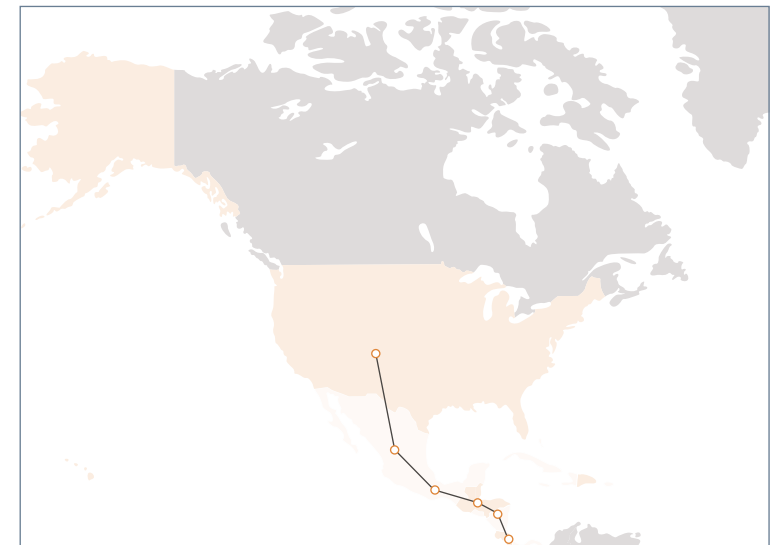
IN 2020—A US PRESIDENTIAL ELECTION YEAR—THERE WILL BE DISCUSSIONS ABOUT CONSTRUCTING A NATURAL GAS PIPELINE FROM THE US TO CENTRAL AMERICA, USING MEXICO AS THE ROUTE.

The year is 2020, and the next US presidential election is upon us. Candidates take the stage and are posed with the following topic for debate: expansion of US energy trade with Central America.

Central America—and Latin America, more broadly—is experiencing an [energy transformation](#), and the region's growth shows no signs of slowing. The question of how the US can best tap into that emerging market will continue to persist well into 2020, particularly as it relates to the demand for natural gas in the region. While nations around the world embrace natural gas as an alternative, more environmentally-friendly energy source, this option is largely inaccessible to Central American countries. That reality is shifting, as Panama breaks ground on the construction of the region's first LNG export terminal, the Costa Norte LNG Terminal. In the meantime, countries like [Guatemala](#) lack a consistent and reliable supply of natural gas, creating a natural opportunity for the US.

Central to the debate about strengthening trade with the region is developing the necessary infrastructure. Constructing a new pipeline through Mexico into Central America, or extending one of the nearly 20 US-Mexican gas pipelines, has been proposed as the conduit for natural gas trade in the region.

While the ultimate outcome of that discussion is largely dependent upon the resolution of the North American Free Trade Agreement (NAFTA) renegotiations and the winner of the 2020 election, we can predict one thing for certain: The possibility of constructing a pipeline between the US and Central America will be revisited during the next presidential debate.



OH, OH, WE'RE HALF WAY THERE: RENEWABLES & ENERGY INDEPENDENCE

PREDICTION 5

RENEWABLES

THE US RENEWABLE ENERGY MARKET WILL PROVIDE 20 PERCENT OF THE NATION'S ELECTRICITY BY 2020.

Renewables accounted for [12 percent](#) of domestically-produced energy overall and [nearly 15 percent](#) of the US's total electricity generation in 2016, and alternative energy investments are set to accelerate. Central to the question of bolstering US renewables is strengthening the necessary infrastructure and expanding the nation's electric grid. By 2020, renewable energy will provide 20 percent of the US's electricity.

The US's recent departure from the 2015 Paris Agreement changes the perception of the nation as a global leader on renewables, but investment will by no means halt. Large US oil companies—among them BP, Chevron, and Total—are all invested in the renewable energy space, a move suggesting Big Oil factors renewables into the energy mix of the future.

Renewable energy is a critical factor compelling the US toward energy independence. This milestone is twofold, referring to self-sufficiency in both electrical and oil supplies. The US has already achieved partial energy independence, from an electrical supply standpoint, which relies on coal, natural gas, and hydro-renewables.

True energy independence—eliminating US dependency on foreign oil and gasoline—will remain beyond our grasp in 2020, however. Oil prices are likely to remain in the \$50 to \$60 per barrel range through 2020, effectively removing the incentive for production in higher-cost regions like oil sands in Canada and deep water offshore regions in the Gulf of Mexico. Seventy-five percent of US-consumed petroleum was produced in the US in 2016, according to the [EIA](#). While the US will continue to strengthen its energy security, the scale won't tip to 100 percent by 2020.

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