



Technical White Paper: High-Efficiency Permanent Magnet Energy-Saving Drive Systems for Oilfields

1. Executive Summary

1.1 Global Context: The Urgency of Energy Transition and Decarbonization

The global energy landscape is undergoing a profound transformation. Under the framework of the **Paris Agreement**, over 130 countries have committed to "Net Zero" targets, placing immense pressure on the oil and gas industry—a key sector for carbon emissions—to reduce its footprint. The **International Energy Agency (IEA)** identifies improving industrial operational efficiency as the most direct and cost-effective measure to reduce greenhouse gas emissions in the short term.

Simultaneously, volatile global energy prices, coupled with increasingly stringent environmental regulations worldwide—such as the **EU's Carbon Border Adjustment Mechanism (CBAM)** and strict noise control standards in major oil-producing nations—are compelling operators to seek technologies that simultaneously lower Operating Expenditures (OPEX), enhance energy efficiency, and meet high **HSE (Health, Safety, and Environment)** standards. Traditional induction motor drive systems, plagued by low efficiency, frequent maintenance, and noise pollution, can no longer adapt to the new normal of green development in international oilfields.

1.2 Jingtao Energy's Solution

In this global context, Dongying Jingtao Energy Technology Co., Ltd.



(hereinafter referred to as "Jingtao Energy") presents the next-generation "High-Efficiency Permanent Magnet Energy-Saving Drive System for Oilfields." Based on advanced Rare Earth Permanent Magnet Synchronous Motor (PMSM) technology and combined with direct/semi-direct drive topologies, this solution is designed to completely replace the inefficient "Asynchronous Motor + Belt + Gearbox" configurations widely used globally.

1.3 Key Value Propositions

Engineered to meet and exceed international ultra-high efficiency standards (IE5 Super Premium Efficiency), Jingtao Energy's systems deliver revolutionary value to oilfield operators worldwide:

- **Significant Energy & Carbon Reduction:** Field data confirms a comprehensive electricity saving rate of 15%-20%, directly drastically reducing Scope 2 emissions and aiding companies in achieving ESG goals.
- **Power Quality Optimization:** Natural power factor improvement to 0.95-0.98 eliminates the need for external capacitor banks, reduces grid strain, and avoids reactive power penalties.
- **Ultimate Environmental Compliance:** Operational noise is reduced to 55-60 dB (a decrease of ~25 dB compared to traditional systems), perfectly resolving noise complaint issues in residential areas, nature reserves, and ecologically sensitive zones.
- **Minimized OPEX:** The innovative "Belt-Free" design eliminates the need for replacing wear-and-tear parts, significantly extending the equipment lifecycle and achieving "Install-and-Forget" maintenance-free operation.
- **Global Adaptability:** Products possess extreme environmental adaptability, ensuring stable operation whether in the shale fields of North America, the high-temperature deserts of the Middle East, the extreme cold of Central Asia, or on offshore platforms.

This white paper details the technical principles, product portfolio, and global application cases of Jingtao Energy, demonstrating that



our solution is not merely an equipment upgrade, but a **strategic choice** for the global oil and gas industry to achieve sustainable, low-cost, and compliant production.

2. Industry Challenges

Oilfield operators worldwide face the following core challenges with traditional pumping unit and Progressive Cavity Pump (PCP) drive systems:

- **High Energy Consumption & Low Efficiency:** Traditional "Induction Motor + Belt Drive" systems suffer from low transmission efficiency (typically <85%) and severe "oversizing" phenomena, leading to massive active power losses and soaring energy costs.
- **Exorbitant Maintenance Costs (OPEX):** Frequent replacement of belts, sheaves, and gearboxes incurs high costs, especially in remote or offshore locations where labor and downtime costs are prohibitive.
- **Stringent Environmental Regulations:** Noise restrictions are tightening globally (e.g., standards in Europe and North America often require <65 dB). The 80-86 dB noise level of traditional systems frequently leads to fines, production limits, or even shutdowns, particularly near communities.
- **Grid Stability & Power Quality:** The low power factor of traditional motors causes significant reactive power loss. In developing countries with weak grid infrastructure or remote areas, this easily triggers grid fluctuations or necessitates expensive capacity upgrades.
- **Safety Hazards:** Exposed high-speed belt drives pose mechanical injury risks, failing to meet the high standards of modern international HSE management systems.

3. Core Technical Principles

Jingtao Energy's systems utilize **Rare Earth Permanent Magnet Synchronous Technology**, combined with advanced electromagnetic design and mechanical innovation, to



fundamentally transform the energy conversion method of oilfield drive systems.

3.1 Permanent Magnet Synchronous Drive (PMSM)

Utilizing high-performance rare earth permanent magnets to establish the rotor magnetic field eliminates the need for excitation current, thereby completely removing rotor copper losses.

High Power Factor: Achieves a natural power factor of 0.95-0.98 without additional compensation capacitors.

Wide High-Efficiency Zone: Maintains high efficiency across a 20%-100% load range, with rated efficiency exceeding 95.8%, far surpassing the IE5 Super Premium Efficiency standard.

3.2 Direct & Semi-Direct Drive Topologies

Belt Elimination: Removes traditional belts, sheaves, and sliding rails, adopting coaxial connections or gearbox direct drives.

Shortened Transmission Chain: Reduces intermediate transmission links, increasing mechanical transmission efficiency by 5%-10% and completely eliminating belt slippage losses.

Compact Structure: Reduces equipment footprint, lowers foundation construction costs, and facilitates modular transport and installation.

3.3 Intelligent Variable Frequency Control Strategy (VFD)

Wide Frequency Speed Regulation: Supports stepless adjustment from 50-1000 rpm, precisely matching oil well condition changes (stroke rates of 0.5-7 strokes/min).

Soft Start/Stop: Limits starting current to less than 30% of the rated current while providing up to 3x rated torque, eliminating mechanical shock and protecting the grid.

Closed-Loop Protection: Features protection against over-voltage, phase loss, overload, upper/lower dead-point flipping, and remote SCADA communication.



3.4 Switched Reluctance Technology (SRT)

Dual Torque Mechanism: Fully utilizes both reluctance torque and magnetic torque for extremely high power density.

High Reliability: Strong fault tolerance; the motor does not burn out during phase loss, and controller failures do not cause short circuits. Ideal for unstable grids or extreme harsh conditions.

4. Product Portfolio & Architecture

4.1 Variable Frequency Permanent Magnet Semi-Direct Drive Motor

- Positioning: Replacement for traditional "Induction Motor + Belt + Gearbox" systems on Beam Pumping Units.
- Core Advantages:
- Ultimate Energy Saving: Comprehensive electricity saving rate of 15%-20%.
- Ultra-Low Noise: Operational noise at 58-60 dB, meeting the strictest environmental requirements.
- Maintenance-Free: Eliminates belt replacements; bearing life is significantly extended.
- Turnkey Service: Provides comprehensive maintenance support to ensure long-term worry-free operation.

4.2 Screw Pump (PCP) Permanent Magnet Direct Drive Motor

- Positioning: Next-generation drive head designed specifically for high-viscosity oilfield Progressive Cavity Pumps.
- Structural Innovation: Hollow shaft design mounts directly onto the polished rod, eliminating all intermediate transmission mechanisms.
- Performance Metrics:
- Operational efficiency $\geq 93.0\%$.
- Noise controlled below 55 dB.
- Load Capacity: Lower bearing supports >20 tons of dynamic



load.

- Safety Features: Fully enclosed design eliminates mechanical injury hazards.

4.3 Switched Reluctance Speed-Regulating Motor

- Positioning: First choice for high-reliability scenarios requiring frequent starts/stops and forward/reverse operations.
- Features: High system efficiency, no starting inrush current, and superior resistance to harsh environments.

4.4 Other High-Efficiency Motor Series

- High-Efficiency Three-Phase PMSM: Simple structure, strong overload capacity, wide economic operating range.
- Multi-Pole Multi-Speed Motors: Achieves pole-changing speed regulation via winding transformation, suitable for wells with large load variations but infrequent parameter adjustments.
- Permanent Magnet Geared Motors: Integrated dual-speed gear reducer, suitable for low-production, low-efficiency wells; offers high output torque and low temperature rise.
- PM Reluctance Hybrid Speed-Regulating Motors: IE5 Super Premium Efficiency class, power range 30kW-355kW, balancing high power density with cost-effectiveness.

4.5 Supporting Control System: Intelligent Oilwell VFD Cabinet

- Functions: Integrated PID control, multi-speed settings, Modbus/Profibus communication, and comprehensive electrical protection.
- Features: Supports upper/lower dead-point flipping for vertical lift units and external limit switching; features local/remote debugging capabilities, compatible with global mainstream SCADA systems.

5. Core Advantages & Value Analysis



Dimension	Traditional Induction System	Jingtao Energy PM System	Customer Value (International Perspective)
Efficiency Class	IE2 / IE3	IE5 (Super Premium)	Electricity bills reduced by 15%-20%; rapid ROI.
Power Factor	0.4 - 0.6 (Requires Compensation)	0.95 - 0.98	Avoids utility penalties; maximizes transformer utilization.
Noise Level	80 - 86 dB	55 - 60 dB	Complies with strict noise regulations in EU/US & eco-sensitive zones.
Maintenance Frequency	High (Belts, Bearings)	Very Low (Belt-Free)	Significantly reduces labor/spare parts costs; increases uptime.
Transmission Efficiency	85% - 90%	95% - 98%	Minimized energy loss.
Policy Incentives	None	Eligible	Qualifies for green energy subsidies or tax credits in many countries.

6. R&D Capabilities & Certifications

Jingtao Energy possesses deep technical accumulation and a manufacturing system compliant with international standards:

- Corporate Qualifications:
 - ◆ National High-Tech Enterprise
 - ◆ Provincial "Specialized and New" SME
 - ◆ Primary Drafter of National Permanent Magnet Motor Standards



- ◆ A-Level Tax Credit Enterprise
- R&D Platforms:
 - ◆ Partner of CNAS Accredited National Laboratories
 - ◆ Municipal Key Laboratory for Energy-Saving Motors
 - ◆ Joint R&D mechanisms with renowned domestic and international universities
- Manufacturing & Testing Equipment:
 - ◆ Production: Imported VPI Vacuum Pressure Impregnation equipment, welding robots, automatic winding machines, intelligent CNC lathes, and automatic painting lines to ensure consistent craftsmanship.
 - ◆ Testing: Equipped with full motor type-test systems, outgoing comprehensive test systems, silicon steel/magnet performance testing equipment, hammer impact testers, and high-precision bearing vibration analyzers. All ex-factory products undergo rigorous testing.
- Intellectual Property: Holds multiple invention and utility model patents covering electromagnetic design, mechanical structures, and control algorithms, ensuring autonomous and controllable technology.

7. Application Scenarios & Case Studies

7.1 Applicable Scenarios

- High Noise-Sensitive Zones: Oil wells near residential areas, scenic spots, and nature reserves (Europe, North America, and densely populated regions).
- Marginal/Low-Production Wells: Wells requiring frequent parameter adjustments and extremely low stroke rates.
- High-Viscosity Heavy Oil Fields: PCP wells requiring high starting torque and smooth operation (e.g., Canadian Oil Sands, Venezuelan Heavy Oil).
- Grid-Constrained Areas: Remote well sites or island oilfields requiring improved power factor and reduced starting current.

7.2 Market Application & Partnerships



Jingtao Energy products have been deployed on a large scale in China's major oilfields and possess strong export service capabilities. Partners include:

- Sinopec: Shengli, Zhongyuan, Jiangnan Oilfields, etc.
- CNPC: Changqing, Tuha, Dagang, Qinghai Oilfields, etc.
- Others: Yanchang Oilfield and major domestic pumping unit manufacturers (as a core component supplier).
- Note: Jingtao Energy is actively expanding into markets in the Middle East, Central Asia, South America, and North America. Product parameters can be customized according to local grid standards and climatic conditions.

7.3 Performance Summary

In actual operation, Jingtao Energy systems demonstrate exceptional stability and economics:

- Energy Saving Effect: Average active power saving rate stabilizes in the 10%-20% range, with a typical investment payback period of 1.5-2.5 years.
- Maintenance Reduction: Completely solves the problem of frequent belt breakage and replacement, achieving "Install-and-Forget" maintenance-free operation.
- Environmental Improvement: Multiple well sites near residential areas achieved a zero noise complaint rate after retrofitting, ensuring harmonious community relations.

8. After-Sales Service System

Jingtao Energy commits to providing full lifecycle technical support and service guarantees for global customers:

- Service Network: Establishment of service centers covering major oil-producing regions to provide localized support.
- Response Mechanism:
 - ◆ 24/7 Global Technical Support Hotline.
 - ◆ 4-Hour Rapid Response Mechanism.



- **Warranty Commitment:** Provides a comprehensive warranty of no less than 2 years, with options for long-term maintenance agreements.
- **Technical Training:** Provides detailed operation manuals and on-site/remote technical training to ensure local teams master operation and maintenance skills.

9.Conclusion

Dongying Jingtao Energy Technology Co., Ltd. is redefining the efficiency standards of global oilfield drive systems with its leading permanent magnet technology, powerful R&D and manufacturing capabilities, and rich field application experience. Our solution is not just an equipment upgrade; it is a **strategic partner** for global oil and gas enterprises to achieve the goals of "**Energy Saving, Consumption Reduction, Green, and Environmental Protection.**"

Facing the wave of global energy transition, Jingtao Energy will continue to uphold the concept of innovation-driven development, striving to become the **most trusted green energy solution provider** for the international oil and gas industry, helping global customers move towards a cleaner, more efficient, and sustainable future.

Contact Us

- Company Name: Dongying Jingtao Energy Technology Co., Ltd.
- Website: <https://jingtaoenergy.com>
- Email: info@jingtaoenergy.com
- International Hotline: +86-18661390903
- Address: Dongying, Shandong, China