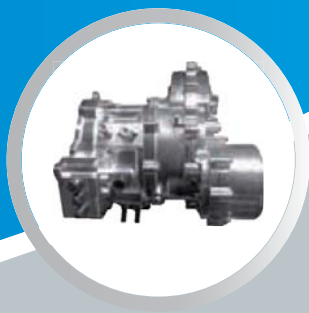
常州海科新能源技术有限公司

Changzhou Haike New Energy Tech Co.,Ltd



常州海科新能源技术有限公司
Changzhou Haike New Energy Tech Co.,Ltd
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CHK
海科新能源
HAIKE NEW ENERGY TECH CO.LTD.

关于海科新能源
Company profile

常州海科新能源技术有限公司（简称海科新能源）成立于2012年1月，是国内首家致力于飞轮混合动力系统技术研发和产业化的创新型高科技创业公司，其自主开发的具有独立知识产权的“电动式”飞轮混动系统——循环型动能推进系统®，具有无与伦比的性价比优势，产业化风险小，市场覆盖面广。该项技术的开发应用不仅将彻底打破日系汽车厂商在新能源汽车上的技术壁垒和市场垄断，还将为全球汽车业开辟一条崭新的技术发展途径。海科新能源以市场为导向，结合人才和技术发展战略，勇于担当技术的领跑者和产业化的开拓者。

海科新能源矢志于2014年在国内率先实现产业化突破，建立起产品体系和自主知识产权体系，打造一个以飞轮混动系统为龙头的核心部件产业链。

Changzhou Haike New Energy Tech Co., Ltd. (HAIKE) is a high-tech startup devoted to the R&D and industrialization of flywheel kinetic energy recovering system (KERS). Founded in January 2012, HAIKE is regarded as the first innovative enterprise in China to industrialize this cutting edge technology. Recycling Kinetic Energy Propulsion System® (REProp®) is HAIKE's indigenously developed “electric type” flywheel KERS with self-owned IPR. REProp® is an outstanding solution to clean energy vehicle (CEV) with high cost-effectiveness, low industrialization risk, and huge market coverage potential. This technology shall not only break the technique barrier and market dominance in clean energy vehicle industry by Japanese automakers, but also create a new technique approach for global auto industry.

Built on market-oriented approach as well as talent & technology development strategy, HAIKE is shaping itself as a leader in technology and a pioneer in industrialization. Our vision is to be the first company in China to industrialize this cutting-edge technology by 2014, providing a wide product mix based on a comprehensive indigenous IP portfolio and forming an industrial chain led by “electrical type” flywheel KERS.

愿景
Vision

以世界一流的技术	Building a world class brand with
世界一流的人才	World-class Technology
世界一流的管理	World-class Talents
世界一流的质量	World-class Management
世界一流的服务	World-class Quality
打造世界一流的品牌	World-class Service

海科精神
Values

核心团队

张仁琪 Renqi Zhang
董事长 Chairman

长期在国内汽车行业工作并担任要职，现任中发联投资有限公司董事长兼总经理。曾任机械工业部和国务院机械工业委员会工程师、国家计划委员会总工程师和轻纺司司长、中国汽车工业总公司董事长代表。

Mr. Zhang has several tens of years experience as senior officer in auto industry. He is the chairman and director in China Automobile Development United Investment Co., Ltd. (CDUI). He once served as engineer in Ministry of Machine-Building Industry and Machine Industry Committee of the State Council, CTO and chief secretary of State Development Planning Commission, representative of Chairman in China Automotive Industry Corporation.

廖越峰 Frank Liao
总经理 CEO

电驱动系统和动力总成资深专家，“千人计划”入选者，曾任北汽新能源总工程师。在美期间参加并主持多项美国能源部资助的新能源汽车项目，回国后曾任奇瑞汽车工程院总工。领导开发了奇瑞 M1EV 和北汽 BC30EV，获 2010 全行业年度电动车型大奖。毕业于清华电机系，拥有美国威斯康辛大学电驱动博士学位。

Dr. Liao is a leading expert in motor engineering, the nominee of China’s “Recruitment program of global experts”, CTO of BAIC EV. He conducted a series of clean energy vehicle development projects funded by the US DOE, and then served as CTO in Chery’s engineering institute. He led the development of EV model M1EV in Chery and BC30EV in BAIC, which was awarded Prize of Yearly EV Model in 2010. He graduated from Tsinghua University, and holds a PhD degree in electrical driving engineering from University of Wisconsin.

陆帅 Shuai Lu
技术顾问
Technical Advisor

高功率密度电机及控制器设计制造的专家，首批“青年千人计划”入选者，重庆大学教授、博导。曾在美国 MTS 系统公司担任主任工程师，带领团队开发了法拉利汽车 F1 赛车第一代混合动力的电驱动系统，获 2010 年度法拉利创新大奖。他于美国密苏里大学-罗拉工程分校获得博士学位。

Dr. Lu is a leading expert specialized in designing and manufacturing of high power density motor and control system, nominated by China’s “Recruitment Program of Global Experts”. He is also a professor and PhD supervisor in Chong Qing University. When worked with MTS as senior engineer in the US, he led the development of hybrid electrical power train for Ferrari F1 racing car, which was awarded “Ferrari Innovation Prize” in 2010. He holds a PhD degree from University of Missouri Rolla.

海科新能源 HAIKE NEW ENERGY TECH CO.LTD.

Expert Team

Chris Ellis
首席技术顾问
Chief Technical Advisor

美国海科公司创始人和 CEO，英国著名汽车动力专家，飞轮混合动力技术的创始人。于 2001 年首倡飞轮辅助动力系统，在欧美申请了多项专利，十几年致力于推广飞轮混合动力系统技术的应用。曾是 IBM（英国）技术总监，拥有 Bristol University 的工程学位。

Mr. Ellis is the founder and CEO of Hykinesys, Inc. in the US, a distinguished expert in vehicle power train, and the founder of flywheel KERS. He initially proposed the concept of flywheel KERS in 2001 and patented a series of IP in Europe and the US. He has dedicated in the application of flywheel KERS for 10+ years. He once served as technology supervisor in UK branch of IBM. Mr. Ellis holds a B.E from the department of engineering from Bristol University, UK. .

费扬 Yang Fei
技术顾问
Technical Advisor

电源研究和产业化资深专家，“千人计划”入选者，任常州万伏电池有限公司董事长、江苏大学特聘教授、苏州大学产业教授，澳大利亚国家核子科学技术研究院终身科学家。在世界权威学术期刊发表 20 多篇论文，获得 18 项发明和实用新型专利。毕业于香港中文大学物理和新材料科学专业。

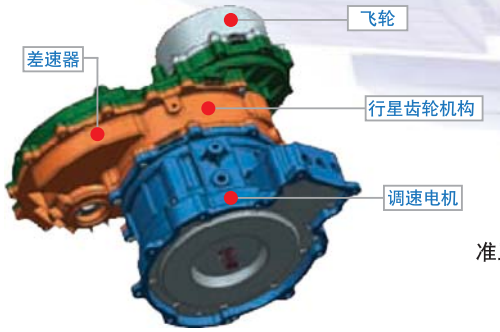
Dr. Fei is a leading expert in power battery, nominated by China’s “Recruitment program of global experts”. He serves as the chairman of Jiangsu Panvolt New Energy, and professor in Jiangsu University and Suzhou University. He was honored as tenured scientist by Australia Nuclear Technology Institute. He has published 20+ academic papers in international authoritative academic journals and has been granted 18 patents in battery. He holds a PhD degree in physics and new material from The Chinese University of Hong Kong.

袁一卿 Yiqing Yuan
技术顾问
Technical Advisor

汽车动力总成系统资深专家，现任中科深江电动车辆有限公司副总经理，中科院研究员和博导，“千人计划”入选者。在美国戴一克、克莱斯勒公司参与过多个汽车动力总成系统的开发。近期研发的零部件已实现小批量生产。毕业于清华大学，拥有美国弗吉尼亚理工学院及州立大学博士学位。

Dr. Yuan is a leading expert in vehicle power train, nominated by China’s “Recruitment program of global experts”. He serves as deputy director in UCAS-EV, and researcher and PhD supervisor in CAS. He participated in vehicle power train R&D programs when working with D-C and Chrysler. The recently developed key components in UCAS-EV have been produced at a small scale. Dr. Yuan graduated from Tsinghua University and holds a PhD degree from Virginia Polytechnic Institute and State University.

产品



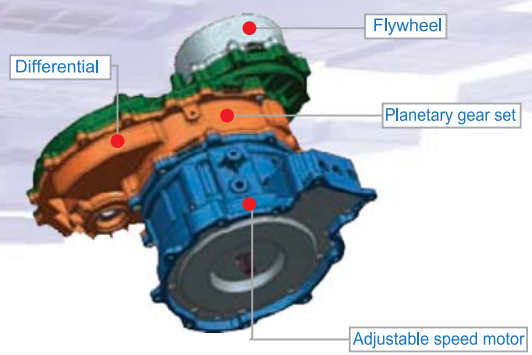
循环型动能推进系统®
—“电动式”飞轮混动系统

具有节能效果显著、应用广、成本低等优势，标准工况下可节能30–50%，整车加速性提升50–100%。

海科新能源的“电动式”飞轮混动系统—循环型动能推进系统®是新能源汽车动力系统中的世界最前沿技术，利用飞轮以机械能形式储存能量，将车辆制动的动能转化为飞轮动能，并在车辆加速时释放，提供辅助动力，以增强动力和降低能耗。

该系统将飞轮控制电机与汽车传动系统，以创新的结构通过行星齿轮连接起来，再用创新的控制方法实现新颖的电混合无极变速，将飞轮功率以控制电机额定功率的2到3倍输入输出，实现了飞轮与汽车传动系统间大于50%的直接功率传递。与现有主流技术相比，具有节能效果显著、应用广、成本低等优势。标准工况下可节能30-50%，整车加速性提升50-100%。

Products



Recycling Kinetic Energy Propulsion System (REProp®)
—"electric type" flywheel KERS

- High cost-effectiveness, low industrialization risk and huge potential market coverage
- 30-50% fuel saving under standard operating conditions
- 50-100% boosted in acceleration

“Electrical type” flywheel KERS-Recycling Kinetic Energy Propulsion System (REProp®) developed by HAIKE is a cutting edge technology in power train of CEV. The vehicle’s kinetic energy is recovered when under braking and stored in flywheel in form of mechanical energy. When accelerating, the energy stored in flywheel is released as power assistance to enhance vehicle power performance and reduce fuel consumption.

“Electrical type” flywheel KERS by HAIKE utilizes innovative method of integrating flywheel and control motor into vehicle power train via a planetary gear set and implements electrical continuous variable transmission by an innovative system control strategy. The power is transmitted in or out of flywheel in 2 or 3 times of bigger scale than the specific power rated in control motor and achieves more than 50% of efficiency in power transmission between flywheel and vehicle drive train. In contrast with conventional hybrid technology, it has advantages such as significant reduction in fuel consumption, wide application coverage and low cost. The vehicle equipped with “electrical type” flywheel KERS will achieve 30-50% reduction in fuel consumption and 50-100% boosted in acceleration.

产品基本参数表
Specifications

系统总成 Hybrid System	制动能量回收效率 Brake energy recovery efficiency	>80%（双向）
	峰值制动能量回收功率 Peak brake energy recovery power	>100kw
	储能 maximum energy	125KJ
	重量 Weight	90kg
	输入峰值电功率 Input electric power	35kw
	辅助峰值电功率 hybrid system net power	65kw
	平均机械功率放大系数 Average mechanical power amplifying coefficient	>2
飞轮系统 Flywheel system	重量 Weight	15kg
	峰值功率 Peak power	40kw
	转速 Speed	18000rpm
	效率 Efficiency	>95%
调速电机 Motor	峰值功率 Peak power	25kw
	额定功率 Rated power	12.5kw
	最高转速 Maximum speed	12500rpm

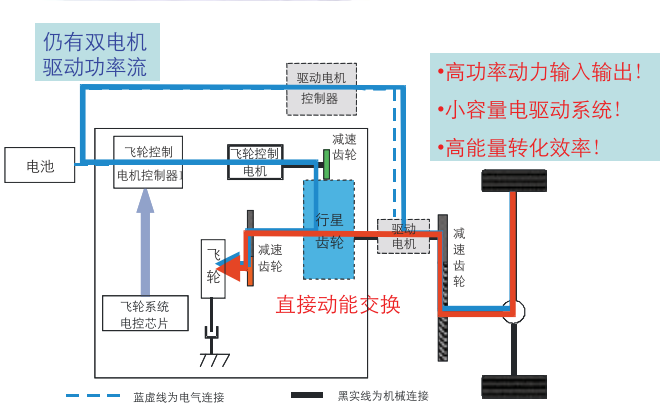
动力电池
Power Battery

控制器
Controller

海科新能源的“电动式”飞轮混合动力系统与Williams Hybrid power 的储能式及Flybrid 的机械式对比：
Comparison among three technical approaches of flywheel KERS:“electrical type” by HAIKE, “energy storage type” by Williams Hybrid Power and “mechanical type” by Flybrid

	Flybrid	Williams Hybrid power	海科新能源 HAIKE
飞轮混动系统的形式 Type of flywheel KERS	机械式 Mechanical	储能式 Energy storage	电动式 Electrical
飞轮的能量输入、输出途径 The transfer route of energy	无级变速器 CVT	电力变换系统 Electrical power system	机械传递为主，电机功率流为辅 Via mechanical coupling and a smaller MGU
能量转换效率 Energy conversion efficiency	效率较高 High efficiency	效率较低 lower efficiency	保留了机械式高效率的优势 High efficiency as “mechanical type”
对电机和控制器的要求 Motor and inverter capacity	低 Low	高 High	相比储能式要求大大降低 Much lower than “Energy Storage Type”
飞轮的运行条件 Operating condition	需要密封 High vacuum	需要密封 High vacuum	大气环境 atmospheric pressure
飞轮最高转速 The max flywheel speed (rpm)	64,500	40,000-45,000	25,000
飞轮材料 Flywheel material	碳纤维复合材料 Carbon fiber composite	磁负载复合技术 MLC technology	金属 Metal
扭矩控制 Torque control	非线形 传递能力低 Nonlinear control	通过电力变换实现 Via electrical conversion	矢量控制 Vector control
对轴承的要求 Bearing	陶瓷轴承 Ceramic ball	陶瓷轴承 Ceramic ball	钢制轴承 Conventional steel ball
飞轮保护装置 Flywheel containment	很高 High	较高 Relatively high	相对降低 Relatively low
系统集成度 System integration	相对较高 Relatively high	不高 Low	相对较低 Relatively low
动力实现形式 Power connection	单一并联动力形式 Parallel only	单一串联动力形式 Series only	多模式动力控制 Multi-modes

海科“电动式”飞轮混动系统的技术优势



海科新能源的飞轮混动系统结构原理图

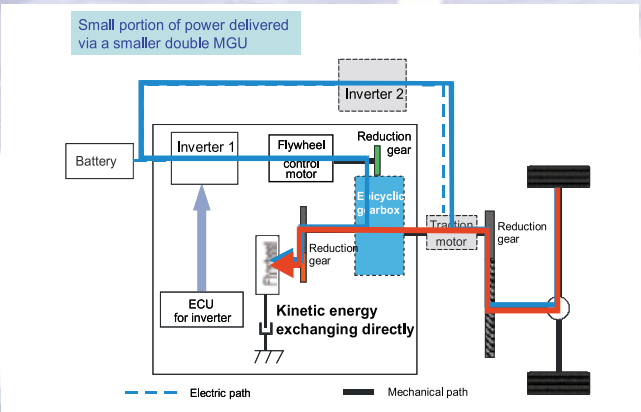
1. 与“储能式”飞轮混动系统相比，海科的“电动式”飞轮混动系统通过行星齿轮机构以机械耦合的方式直接进行动能传输，不需要动能-电能-化学能的转换，刹车动能利用效率高；而调速电机进行辅助功率和能量管理，将电力传动系统的容量要求大大降低。

2. 与“机械式”飞轮混动系统相比，海科使用的是机电一体化的控制系统，以电机通过行星齿轮调速机构取代了“机械式”的CVT调速机构，可以通过电机随时补充飞轮能量，飞轮运行不需真空装置；相比CVT控制的非线形，采用电机的矢量控制可以达到很好的动态控制，实现理想的平顺性和一致性；而使用行星齿轮机构可以有效解决高扭矩连接问题。

3. 海科的飞轮限速25,000 rpm，大大低于其它车载飞轮动力系统；半径设计保守，离心强度超过其它产品的两倍；具有高强度保护罩、飞轮失效保护装置、抵消陀螺效应的结构设计。

4. 适用于多种汽车动力结构，即可无缝集成到电动汽车和多种形式的混合动力汽车上， 也可适用于轿车和重型商用车，还可作为子系统融入到改装车的原有动力系统中。

Advantages by HAIKE’s “electrical type” flywheel KERS



Topology of HAIKE flywheel KERS

1. In contrast with “energy storage type”, HAIKE’s “electrical type” flywheel KERS delivers kinetic energy directly in a mechanical way via planetary gear set without the kinetic-electrical-chemical transformations, leading to high braking energy recovery efficiency. The adjustable speed motor performs as management assistance for power & energy and significantly decreases the dependence upon the capacity of electrical power train.

2. HAIKE’s “electrical type” flywheel KERS utilizes electrical-mechanical control system and the innovative planetary gear set driven by motor as a functional speed ratio converter rather than CVT adopted in “mechanical type”. Flywheel rotating speed is sustained by energy supplemented via motor without the need of vacuum condition. Compared with nonlinear controlling upon CVT, the character of vector controlling upon motor can achieve perfect dynamic control and good ride comfort & consistency. Moreover, the capacity of torque transit by gear coupling via planetary gear set can afford much bigger flow of torque transit.

3. High safety. The speed limitation of flywheel spinning is 25,000 rpm, much slower than the other types. The radius of its flywheel is designed relatively conservative, allowing a lower max peripheral speed and double disintegrating stress. Besides, the safety designs in flywheel containment and the architecture capable of dis-gyroscope are considered.

4. It is suitable for multi types of vehicle power train, e.g. EV, various hybrid vehicles, cars, or heavy duty commercial vehicles. It could be installed into retrofitted vehicle’s power train as a sub system.

核心技术

海科核心技术人员作为专利权人的有关飞轮混动技术的部分专利
Examples of patents on flywheel KERS technology owned by HAIKE experts

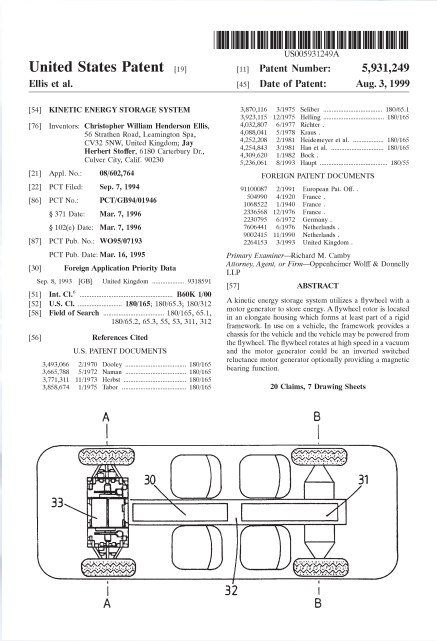
专利号 Patent No.	专利名称 Patent Depiction	专利范围 Coverage	专利权人名称 Owners
GB2405129	Kinetic energy storage system	英国 GB	Chris Ellis
PCT/GB2007/001786	Continuously Variable Transmission Device	全球 Global	Chris Ellis
US 5931249	Kinetic energy storage system	美国 USA	Chris Ellis
US Patent Application No. 60/826,010	Integrated Flywheel-Assisted Hybrid Electric Drive Systems	美国 USA	廖越峰 Dr. Frank Liao
US Patent Application No. 60/826,016	Flywheel-Assisted Hybrid Transmission with Neutralized Gyroscopic Effect	美国 USA	廖越峰 Dr. Frank Liao

海科新能源的核心技术，集中体现在机械集成、电气集成、系统控制三个方面，在现有新能源汽车动力技术上实现突破性创新。海科新能源拥有并正在申报多项专利，形成了完整的IP体系。

飞轮混动系统之父Chris Ellis先生的“利用飞轮的动能存储系统（美国专利号：US005931249A）”发明专利，奠定了整个飞轮混动系统的技术基础。

HAIKE's core technologies, as significant innovations in power train technology of CEV, are concentrated in three areas, including mechanical integration, electrical integration and system control. HAIKE has been granted or is applying for a portfolio of patents to form its comprehensive IP system.

The patent of “Kinetic energy storage system” (US patent No. US005931249A) invented by the founder of flywheel KERS, Mr. Chris Ellis，is the corner stone of flywheel KERS technology.



US005931249A

United States Patent [19]
Ellis et al.

[11] **Patent Number: 5,931,249**
[45] **Date of Patent: Aug. 3, 1999**

[54] **KINETIC ENERGY STORAGE SYSTEM**

[76] Inventors: **Christopher William Henderson Ellis**, 56 Stratten Road, Leamington Spa, CV32 5NW, United Kingdom; **Jay Herbert Stoffer**, 6180 Canterbury Dr., Culver City, Calif. 90230

[21] Appl. No.: **08/602,764**
[22] PCT Filed: **Sep. 7, 1994**
[86] PCT No.: **PCT/GB94/01946**
§ 371 Date: **Mar. 7, 1996**
§ 102(e) Date: **Mar. 7, 1996**
[87] PCT Pub. No.: **WO95/07193**
PCT Pub. Date: **Mar. 16, 1995**

[30] **Foreign Application Priority Data**
Sep. 8, 1993 [GB] United Kingdom 9318591

[51] **Int. Cl.**[6] **B60K 1/00**
[52] **U.S. Cl.** **180/165**; 180/65.3, 180/312
[58] **Field of Search** 180/165, 65.1, 180/65.2, 65.3, 55, 53, 311, 312

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Primary Examiner—Richard M. Camby
Attorney, Agent, or Firm—Oppenheimer Wolff & Donnelly LLP

[57] **ABSTRACT**

A kinetic energy storage system utilizes a flywheel with a motor generator to store energy. A flywheel rotor is located in an elongate housing which forms at least part of a rigid framework. In use on a vehicle, the framework provides a chassis for the vehicle and the vehicle may be powered from the flywheel. The flywheel rotates at high speed in a vacuum and the motor generator could be an inverted switched reluctance motor generator optionally providing a magnetic bearing function.

20 Claims, 7 Drawing Sheets

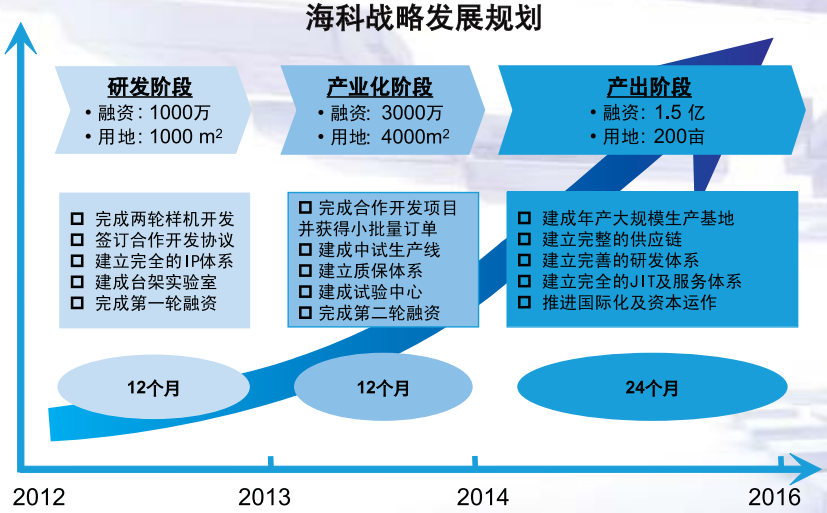
Core Technology

海科正在申报的部分专利内容
Examples of patents HAIKE is applying for

核心技术 Core technology	专利内容 Patent depiction
动力拓扑结构创新 The innovation in topology of vehicle power train	“电动式”飞轮混动系统的总体结构和原理 General construct and principle for “electrical type” flywheel KERS
系统动力控制技术创新 The innovation in system power control method	系统控制类： • “电动式”飞轮混动系统的系统控制策略和装置 电气集成类： • 电磁/超速离合器配飞轮 • 飞轮失效保护装置 System control: • System control strategy and device in “electrical type” flywheel KERS Electrical integration: • Magnetic/overdrive clutch matching with flywheel • Flywheel failure protection device
高速飞轮与行星齿轮技术创新（工艺创新） The innovation in the manufacturing of high speed flywheel and planetary gear set (innovation in technics)	• 单/双行星排，机械飞轮储能装置；双行星轮 • 飞轮到齿轮花键套 • 新的油封装配形式 • 飞溅式和离心式强制结合的特殊润滑结构及高速油封的应用 • 膨胀腔问题解决方案 • Single/dual planetary gear set coupled with energy storage device of mechanical flywheel; dual planetary gears • Spline housing to couple flywheel to gear • Innovative assembling method for oil seals • Innovative construct for lubrication which combines splash lubrication and centrifugal lubrication, with the application of high speed oil seals • New solution for expansion chamber
灵活集成到各种新能源汽车动力结构中的创新（应用创新） The innovation in capable of integrating flywheel KERS into almost all types of power train in clean energy vehicle (innovation in applicability)	“电动式”飞轮混动系统的总体结构和原理 General construct and principle for “electrical type” flywheel KERS

发展规划

海科战略发展规划



阶段性发展目标

研发阶段：2012年

- 第1步：完成原理样机的集成和调试，验证系统基本控制原理，开始功能样机设计。
- 第2步：完成功能样机设计、试制和系统集成；与一大主机厂签订样车合作开发合同；建立测功机台架试验室；初步完成设计、控制和测试团队的建设；申报十余项发明专利和近20项实用新型（设计）专利，构建飞轮混动系统知识产权体系。

产业化阶段：2013-2014年

- 第1步：4-6个月内完成与一个主机厂的合作开发项目，完成装配试制和路面测试、通过国家验证，推出世界首款装置“电动式”飞轮混动系统的新能源汽车，获小批量生产订单，实现产业化突破；争取到科技部“国家新能源科技项目”立项，获得国家技术和资金等支持。
- 第2步： 6-8个月内建立中试生产线和质保体系，达到年产1万套产能；建成完整的开发实验室和试验中心。

产出阶段：2015-2016年

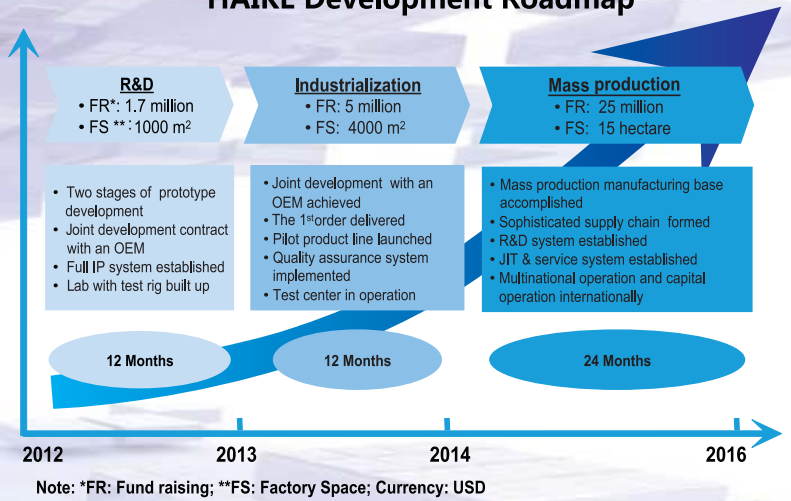
- 建立完善的研发体系、完全的JIT及服务体系；
- 打造以飞轮混动系统为核心的新能源汽车核心部件完整的产业链；
- 推进国际化及资本运作；
- 2015年实现1万套产品销售，销售额3亿元；2016年实现10万套产品销售，销售额30亿元，年利润5亿元。

跨越式发展阶段：2017-2020年

- 2020年前达到100万套产能，产值300亿元，国内市场占有率达到20%，并成为世界级的跨国公司；
- 缔造中国汽车行业第一个真正具有完整核心技术和知识产权、具有国际竞争力的动力总成一级系统集成商。

Development Roadmap

HAIKE Development Roadmap



Note: *FR: Fund raising; **FS: Factory Space; Currency: USD

Development roadmap

Phase 1: R&D (2012)

- Step 1: Integration and debugging for principle of prototype; Demonstration for the theory of foundation to “electrical type” flywheel KERS; Functional prototype development launched.
- Step 2: Implementing full development procedure on functional prototype; A joint development contract with an OEM upon CEV equipped with flywheel KERS achieved; A lab equipped with test rig built up; A full function of R&D team involving design, system control and testing initially formed; A comprehensive IP system founded.

Phase 2: Industrialization (2013-2014)

- Step 1: The joint development in CEV with an OEM achieved in 4-6 months; The world 1st CEV installed with “electrical type” flywheel KERS launched after series of matching experiment in CBU, road testing and certificated by relevant state authority; Batches of order from the OEM delivered, indicating a milestone for industrialization of “electrical type” flywheel KERS; The development project of “electrical type” flywheel KERS approved by China MOST as state incentive project in National clean energy vehicle technology program.
- Step 2: A pilot product line with 10,000 units of annual output constructed and a certificated quality assurance system implemented in 6-8 months; A full function development system and well- equipped lab built up.

Phase 3: Mass production (2015-2016)

- Development targets:
  A perfect R&D system formed, JIT management system implemented effectively, a quick response and big coverage service system in operation;
  Sophisticated supply chain formed;
  Multinational operation and capital operation internationally.
- Revenue targets:
  10,000 units of product sold in 2015 and USD 50M annual revenue achieved; 100,000 units of product sold in 2016 and USD 500M annual revenue achieved.

Phase 4: Leapfrog development (2017-2020)

- 1 million annual output capacity, USD 5 billion revenue and 20% market share in China achieved by 2020; HAIKE as a world-class multinational enterprise formed.
- Shaped as the 1st world class T1 in vehicle power train derived from Chinese corporations in auto industry depending on its core & global competitiveness and full IP system.