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DIESEL PROGRESS

Products, Technology & Industry News For All The Engine-Powered Equipment And Component Markets

Iveco And Iveco Motors: The New Brand For Industrial Engines

By Riccardo Tardì
Senior Vice President
Iveco Powertrain

Iveco, belonging to the Fiat Group, is one of the leading European manufacturers of industrial vehicles and its name and reputation are internationally recognized. Iveco Motors is a new brand name created just over one year ago to distinguish all company activities related to the development, production and sales of diesel, spark-ignited gas engines and other driveline components. These are used internally to power Iveco trucks and buses and are also available in the marketplace to OEMs looking for power units to drive special on- and off-highway vehicles.These include engines for agriculture, construction and mining, marine propulsion — both work boats and pleasure craft — railway traction and power generation.

Iveco Motors diesel engines are available with displacements from 2.3-40 L, covering a power bracket between 40-1600 kW (54-2145 hp).

In this segment the present worldwide market is around 9.4 million engines per year, which is forecast to increase about 20% in the next four years.

Iveco Motors engine production in 2004 has reached more than 430,000 units and is still on the rise. With such production levels, Iveco Motors ranks fifth in the worldwide scale, well ahead of the sixth manufacturer which delivers only around 50% of Iveco's engine volume.

Such a prestigious role was made possible by continuous heavy investments in R&D, like the €85 million (US$108 million) in 2004, representing over 4% of its turnover.

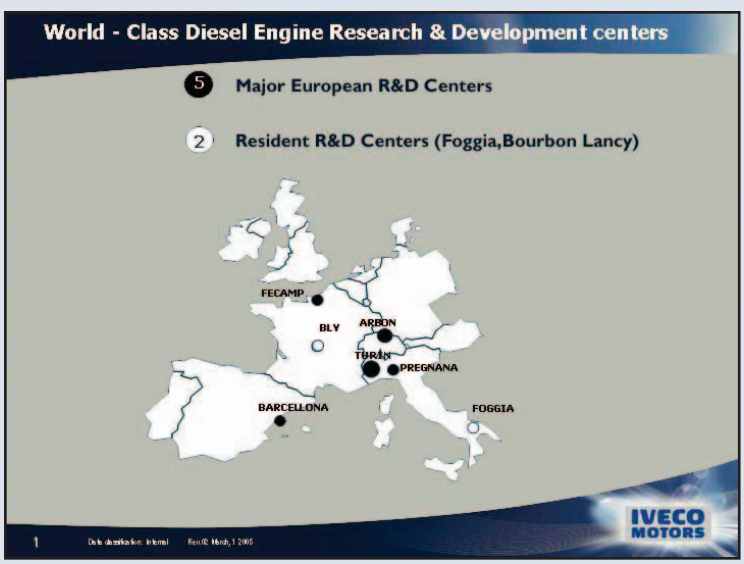
Iveco's five European Engineering Centers, staffed by over 650 engineers and technicians, and equipped with 84 engine test benches and 50 special test rigs, have allowed the company to redesign and issue the whole line of engines to meet all future foreseeable emission standards. The present engine line complies with Euro 4 — and soon to be upgraded to Euro 5 — and Tier 3 emission limits.

This policy has made Iveco the only manufacturer worldwide having an entire engine line featuring only newly designed engine families. This leadership in technology and innovation is possible thanks to the strong captive customer base.

To OEMs outside the Fiat Group, Iveco Motors offers the entire diesel and spark-ignited engine range it produces at its engine plants in Foggia, south Italy for the light-duty Sofim and HPI engines; Torino, Italy, for the medium-duty NEF engines (1 L/cyl) and large (2.5 L/cyl) Vector family; and Bourbon Lancy, France, for the volume produced heavy-duty Cursor family.

The customer base for the 430,000 engines produced in 2004 is subdivided into three segments: 9.5% for the open market, 39% for Iveco's own use and 51.5% for the key customers outside and within the Fiat Group.

Iveco Motors sales from the Powertrain business unit account for about 25% of total Iveco turnover. We are presently engaged in a market penetration program that will allow us to reach the 6.4% compound annual growth rate (CAGR) we have forecast for our activity in the next three years . ★



Iveco's five European Engineering Centers, staffed by over 650 engineers and technicians, and equipped with 84 engine test benches and 50 special test rigs.

Iveco Motors Sales And Service Network

By Luigi Carnino
Sales and Marketing General Manager
Iveco Powertrain

At the end of the assembly process in the various production plants, before assembling of the accessories required for Iveco's vehicular applications, the bare engines for power generation and marine applications, as well as the ones sold on the open market to the various OEMs, are routed to the Pregnana Milanese plant. There, they are tailored according to OEM's specifications to exactly match the application requirements.

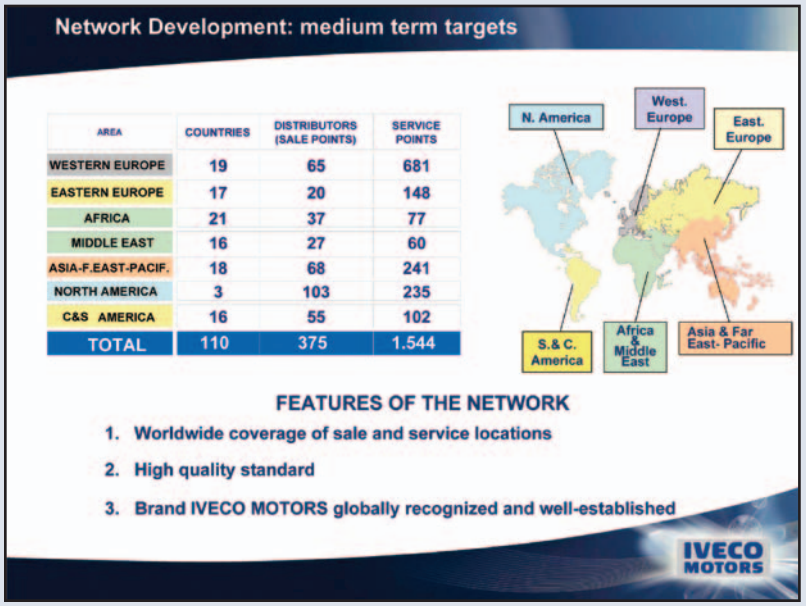
In 2004, about 40,000 engines (9.5% of Iveco's total production) were submitted to the customization process in Pregnana Milanese. This number is forecast to reach 60,000 units by the end of 2007 — a 50% volume rise in three years.

The power range covered by the four engine families is the following:

- SOFIM/HPI 70-125 kW (94-167 hp).
- NEF 40-295 kW (54-395 hp).
- Cursor 180-400 kW (241-536 hp).
- Vector 270-1600 kW (362-2145 hp).

To fulfill its stated targets, Iveco Motors is engaged in the development of its sales and service network, giving priority to the areas where the market penetration looks the most promising. These areas include North America, China, India and South America.

Iveco Motors offers a complete line of light-, medium- and heavy-duty diesel and spark-ignited gas engines.



The Iveco Motors sales and service network.

Special efforts have taken place to penetrate the North American marketplace. The American subsidiary of the Italian company, Iveco Motors of North America, based in Carol Stream, Illinois, began operations in January 2004 and is covering the U.S.A., Canada and Mexico. Before beginning actual engine sales, its main efforts were devoted to establishing a first-class distributor and service network that now counts 100 distributors and nearly 200 service points.

A separate program has been set up to increase the share of long-term supply agreements with key customers inside and outside the Fiat Group.

Iveco's product mix in 2004 shows a 56% share in the light-duty engine class, 34% in medium-duty and 10% in heavy-duty. The mix per application sector shows a 71% share in automotive, followed by 24.5% industrial, 4% power generation and 0.5% marine. The trend in recent years is to gradually decrease the automotive share mainly to the benefit of industrial applications.

Customer care is based on a spare parts order processing system connected to a network of six strategically located virtual warehouses. All American distributors are connected to the U.S. central warehouse in Carol Stream. In the near future, all Far East countries, including Australia, will be served by a new local warehouse.

Great attention has been given to the training of service personnel which has to be promoted by local distributors for all service points located in their area.

Iveco Motors has an e-learning program presently in the implementation stage for the newly hired service personnel. ★

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Iveco's Long-Term R&D Program

By Gian Maria Olivetti
Product Development General Manager
Iveco Powertrain

The diesel engine is the most versatile and fuel-efficient source of power available today and it will continue to be in the years to come. Yet in spite of recent progress, diesel engine technology still has a lot of potential in terms of performance, fuel economy and environmental impact.

Environmental care and customer needs are our main priorities driving all Iveco engine developing programs, and mastering continuosly evolving diesel injection and combustion technology is the key factor to success.

To manage lower emissions while increasing efficiency and productivity for all applications is no easy task. But Iveco has a unique competitive advantage, as we have just completed a full renewal of our engine range.

Our new engine families, featuring the most advanced technologies and with excellence in terms of performance and specific fuel consumption, represent the best basis for further emission reduction programs.

Each engine family covers a wide power range with an engine line featuring a high commonality of components. This gives the user a competitive advantage in terms of operating flexibility and spare parts inventory.

Born in Euro 3 and Tier 2, those new engine families are now capable of fulfilling Euro 4 European on-highway emissions limits with the use of emissions reduction technologies like EGR or SCR. Most applications are already available at Euro 5 compliance levels, well in advance of the expected mandatory regulation in 2009.

Our off-highway Tier 3 solutions, mainly based on internal EGR technology and designed to have minimum impact on users, are presently available. Tier 4 technologies — which will be introduced in 2011 — based on exhaust gas aftertreatment, cooled EGR and advanced turbocharging, are in the advanced stage of development.

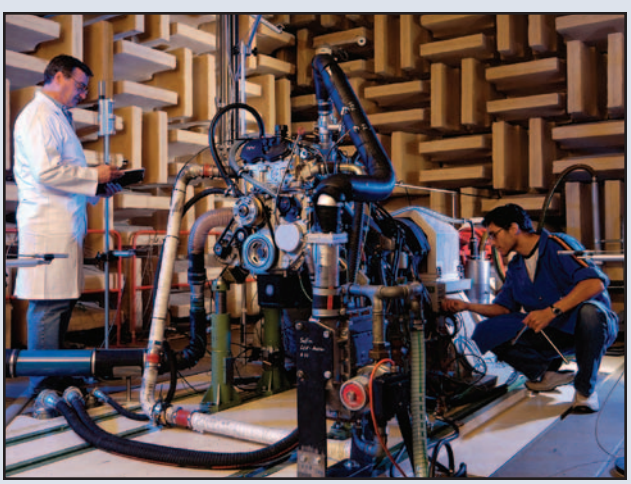
Technological development is going on in several areas and will progressively be applied to the engines offered to the marketplace. The use of variable geometry turbochargers will gradually be extended and sequential two-stage turbocharging will also be extensively applied. More sophisticated electronic engine management and increasing high pressure fuel injection systems — more than 2000 bar (29,000 psi) — will soon be applied to the engines that will feature peak cylinder pressures well over 180 bar (2600 psi).

Iveco is also strongly committed to longer term research areas to take the compression ignition principle even further ahead into the future. Some of these approaches will include alternative fuels and novel combustion concepts, such as highly premixed combustion and Homogeneous Charge Compression Ignition (HCCI), leading to near-zero emissions.

Iveco maintains two primary R&D centers in Torino, Italy, and Arbon, Switzerland. Other engineering facilities mainly devoted to specific application developments are based in Barcelona, Spain; Pregnana Milanese, Italy; and Fécamp, France, and these encompass a total of more than 100 engine test cells and 500 engineers.

Iveco's R&D resources are focused on four development platforms, one for each engine family, plus a fifth platform for highly specialized applications in marine and power generation.

Each development platform maintains a team of specialized engineers in the field of application of the engine family capable of offering standard options as well as customization and system integration. ★



Iveco is strongly committed to long-term research to derive the maximum benefits from diesel engine technology. The company maintains two primary R&D centers in Torino, Italy, and Arbon, Switzerland, where much advanced research is done.

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The Iveco Sofim HPI Engine Family

The Sofim HPI range is the smallest Iveco engine family, covering the 71-125 kW (95-167 hp) power range.

The main product is the four-cylinder HPI engine presently available in the 2.3 L version that comes out of the assembly line of the Foggia plant in southern Italy, along with a 3 L version rated 129 kW (172 hp) that will begin production this year.

This newly designed engine will replace the older Sofim 2.5/2.8 L engine. More than four million units of that engine have been built, and it is still requested in large volumes for those countries and applications not requiring stringent emission limits.

The HPI engine, available in the Euro 4 configuration, can be defined as "best in class" for all applications in regards to its power-to-weight ratio. Its main features are:

- A very robust structural underblock.
- Double overhead camshafts and hydraulic slack adjusters.
- Four valves per cylinder with centrally located fuel injectors.
- A high pressure common rail fuel injection system.
- Wastegated and/or variable geometry turbocharging systems.
- Fully electronic engine management, which allows full on-board diagnostics.

The electronic engine control also allows setting of engine power and torque curves to match the application requirements, so as to guarantee the operator top engine performance.

The HPI engines have been designed for truck application and are expected to reach 350,000 km (217,000 miles) without refurbishing or 5000 hours high load factor operations.

The Sofim HPI range is the smallest Iveco engine family, covering the 71-125 kW (95-167 hp) power range.

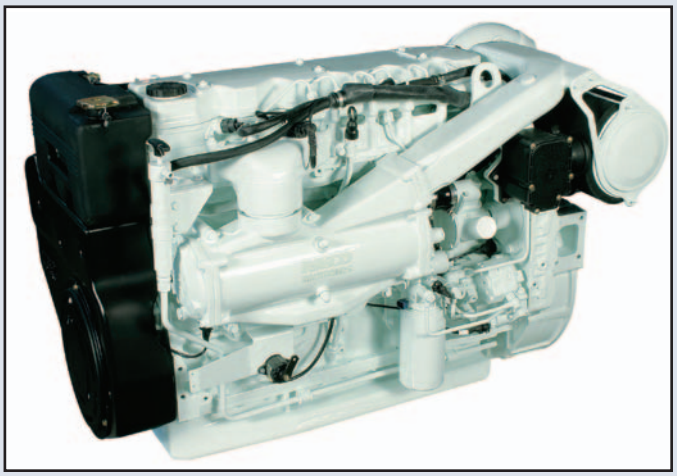
Their fuel consumption is 5-10% less than equivalent engines now on the market and their routine maintenance is planned at 40,000 km (25,000 mile) intervals with no lube oil refilling between intervals.

High driver comfort is obtained by the common rail system which allows multiple injections in the combustion chamber of each cylinder with consequent noise reduction to a level that averages 3 dB(A) less than standard for this engine size.

While originally designed for trucks, the HPI diesels find extensive use in on- and off-highway applications. ★

Iveco Motors produces its light-duty Sofim and HPI engines at its plant in Foggia, in southern Italy.

Iveco's NEF Engine Family



Iveco's NEF (New Engine Family) engines cover an output range of 40 to 295 kW and are one of the company's most versatile engines with applications in automotive, off-highway, marine and power generation.

The NEF (New Engine Family) range was first introduced by Iveco Motors in 2000. For automotive applications, the NEF engines cover the 95-202 kW (127-271 hp) power bracket with four- and six-cylinder configurations and a unitary displacement of 0.98 L/cyl. They incorporate a sophisticated common rail fuel injection system working at 1600 bar (23,000 psi) pressure.

The three-, four- and six-cylinder NEF industrial engines feature a unitary displacement of 0.98 and 1.12 L/cyl and mechanical or electronically controlled common rail fuel injection systems. They cover the 40-186 kW (54-249 hp) power bracket and are available in several configurations. These include two and four valves per cylinder, naturally aspirated or supercharged, with structural engine blocks for load-bearing purposes such as ag tractor applications, etc.

The same engines are available for power generation applications covering an output range of 40-215 kW (54-288 hp).

The marine versions of this family, covering the 53-295 kW (71-395 hp) power bracket, are available in five basic models for pleasure craft and work boats.

Engines equipped with electronic control allow for customized power matching, since the engine's performance can be tailored to each specific application. Interfacing on the CAN-Bus data, the engine Central Unit exchanges data with other electronic units connected to the application and complementing the different requirements to manage the engine as an integrated system.

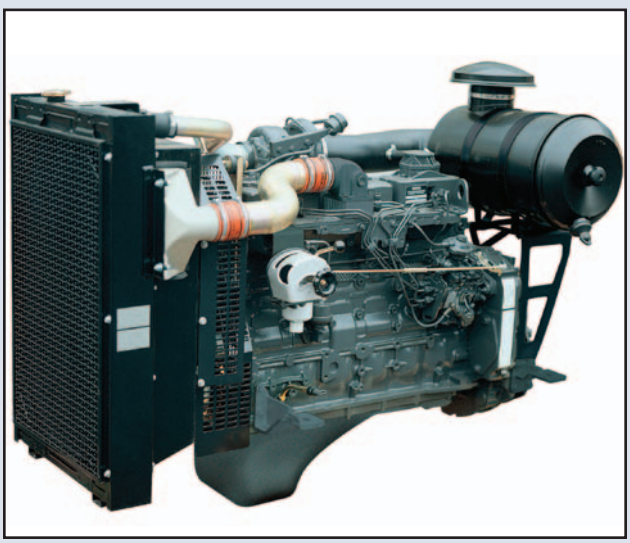
According to customer requests, the turbocharging system can feature an aftercooler, a wastegate and a variable geometry turbocharger.

Noise emissions of the NEF family are among the lowest in their power range with a maximum of 91 dB(A) under full load. The valve timing geartrain is positioned in the rear part of the engine (flywheel side) and can feature narrow or wide gears according to the application.

These engines have been designed to run 600,000 km (372,000 miles) in automotive applications without major overhauls or 8000 hours in industrial applications with high load factor. Their low component number makes them 50% more reliable than the engine of the previous generation.

The same basic engine can be equipped with standard options or tailored to different customer needs with low to high sophistication. This possibility makes the NEF engine family very competitive on the international marketplace.

Recently, Iveco Motors has issued the first prototypes of the NEF automotive responding to Euro 4 emission limits and NEF industrial complying to off-highway Tier 3 standards. ★



The same basic NEF engine can be equipped with standard options or tailored to different customer needs with low to high sophistication. This possibility makes the NEF engine family very competitive in the international marketplace.

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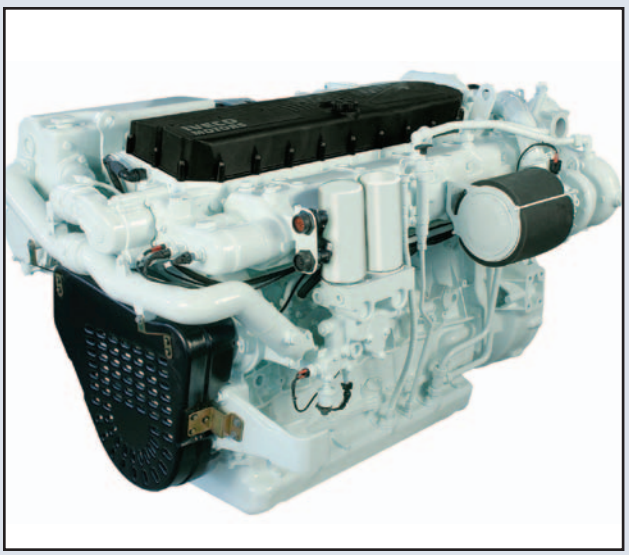
The Iveco Cursor Engine Family



The Iveco Cursor family presently comprises 8, 10 and 13 L engines with a 9 L model to be available in 2006. This engine family covers the 180-570 kW (241-764 hp) power bracket and is used in applications from automotive to marine.

The Iveco Cursor family presently comprises 8, 10 and 13 L engines with a 9 L model to be available in 2006. This engine family covers the 180-570 kW (241-764 hp) power bracket.

The Cursor engines are manufactured in the Iveco plant of Bourbon-Lancy, France, where the company has invested over €180 million (US$ 230 million) in the project.

All Cursor engines feature a six-cylinder, inline configuration. The single-piece cylinder head features four valves per cylinder and carries the overhead camshaft which serves the valve timing system, the fuel unit injectors and the Iveco Turbo Brake system (ITB). The engine block features suspended, wet cylinder liners. The crankshaft is mounted on seven journal bearings placed in a rigid lower frame which is then bolted to the lower part of the engine block.

The Cursor engine line was designed from scratch to comply with present and future emission limits through a fully electronic engine management system. Clean combustion under a wide range of operating conditions is achieved by controlling the fuel metering and injection delay of the electronic unit injectors. These unit injectors operate at an injection pressure around 2000 bar (29,000 psi). The electronically controlled variable geometry turbocharger (VGT) is another unique feature of the Cursor engine line. It extends, the engine operating range and also serves the ITB system (partial opening of exhaust valves).

Combined electronic control of the unit injectors and of the turbocharger allows the engines to operate at full load in the entire speed range from 600 to 2100 r/min, giving full protection against overloads at the same time.

Along with lowering emissions, Iveco's combustion optimization also reflects on fuel consumption and on oil change intervals.

The Cursor engines have been designed to cover 1,000,000 km (620,000 miles) in automotive applications without refurbishing. This is equivalent to 10,000 hours with high load factor in industrial operations.

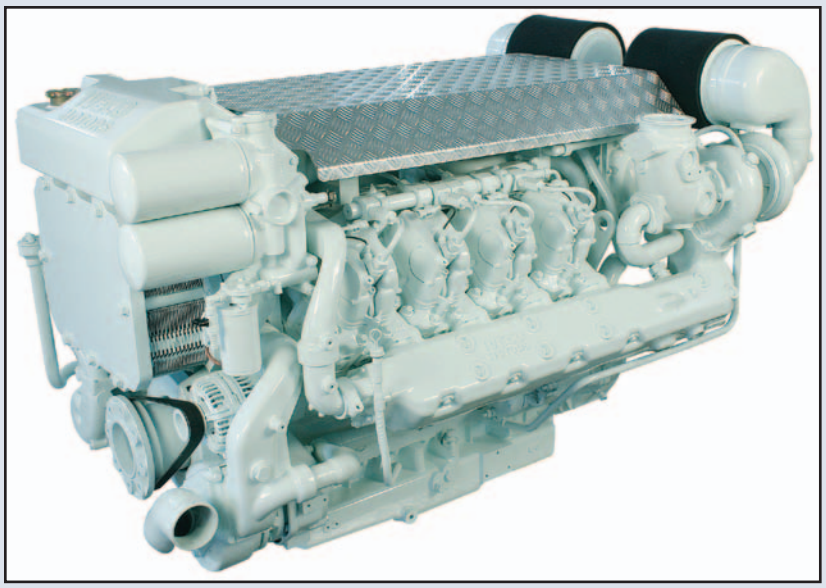
The power ranges by applications are:

- Automotive: 180-400 kW (241-536 hp)
- Industrial: 180-380 kW (214- 509 hp)
- Power Generation: 240-400 kW (322-536 hp)
- Marine: 220-570 kW (295-764 hp)

The new 9 L unit, which will be available in 2006, will incorporate a common rail fuel injection system that will enable it to comply with Tier 3 emission limits from the very beginning of its industrial life. ★

IVECO

The Iveco Vector Engine Family



Iveco's Vector engines are available in a power range of 270-1600 kW (362-2145 hp) and are the only Iveco engines that have no roots in automotive applications.

The Vector engine family is the only Iveco engine line not specifically developed for automotive applications. In fact, their power range of 270-1600 kW (362-2145 hp) is beyond the output required for on-highway truck applications. These engines find application on special vehicles for the mining and construction industry, in defense vehicles, rail traction, marine propulsion and power generation.

These engines have been developed to capitalize on the experience gained on the previous V engine family.

The new Vector engines, available in 8-, 12- and 16-cylinder versions (a six-cylinder unit may extend the power range on the lower side in the future), feature a modular construction with high component commonality and a unitary displacement of 2.5 L/cyl with a nominal output of 100 kW/cyl. The first application of the Vector engine family was in the manufacture of several hundred 20 L rail traction engines with a conservative rating of 560 kW (750 hp) at 2000 r/min.

The 20 L marine Vector 8 engine covers the 500-880 kW (670-1180 hp) power bracket for pleasure craft and workboats.

The design of these types of engines, in both the diesel and spark-ignited version for gaseous fuels, was started back in 1999 with the aim of reaching industrial production in a 36-month timeframe which has been fully respected.

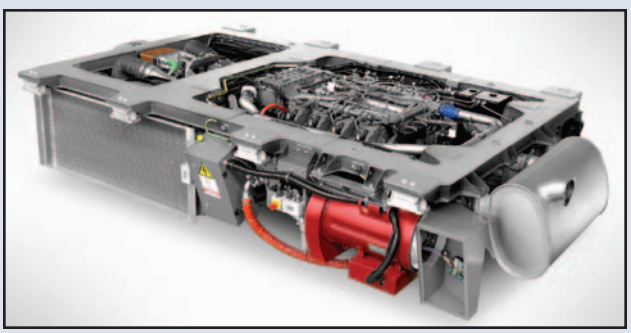
The 90° V configuration of the new family is unchanged in respect to the previous engine family; also the cylinder bore has been maintained at 145 mm while the stroke has been increased to 152 mm and a mean piston speed of 11.7 m/s is obtained at the rotating speed of 2300 r/min. Individual cylinder heads were redesigned maintaining the same four-valve architecture.

The maximum bmep of 24.6 bar (356 psi) and maximum cylinder pressure of 200 bar (2900 psi) have imposed redesign of the whole engine structure, however, the Vector engine family features the same external dimensions of the engine block of the previous engine family.

The diesel version features a state-of-the-art common rail injection system working at 1600 bar (23,000 psi). The high pressure pump is placed inside the V while the two high pressure rails are mounted on the inlet manifolds. All hydraulic components are provided by Bosch.

The whole engine combustion system has then been tested in Switzerland at the Arbon R&D Center. As a result, these engines feature very low fuel consumption (3-10% lower than comparable engines) and emission levels well under Euro 3 specifications, with the possibility of meeting future Euro 4 and Tier 3 limits.

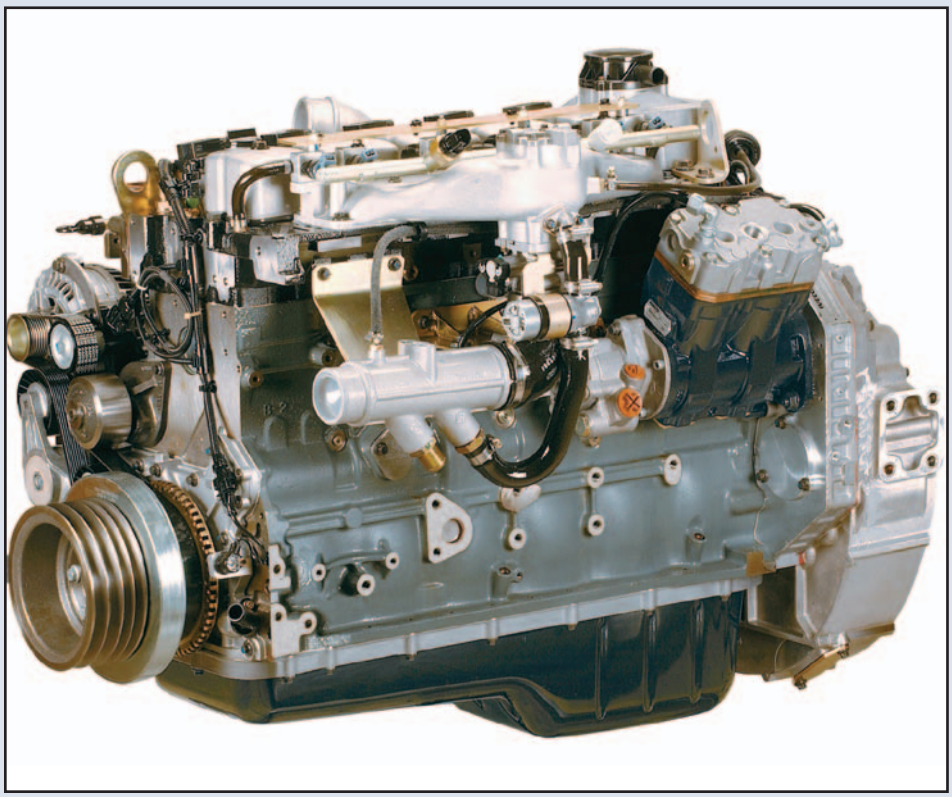
The Vector engines have been designed for over 20,000 hours service in industrial applications. ★



The Vector power pack for rail traction. These engines find application also on special vehicles for the mining and construction industry, in defense vehicles, marine propulsion and power generation.

IVECO

Engines Fueled With CNG And Other Alternative Fuels



Iveco's NEF CNG engines show NO_x emissions 70% lower than Environment Enhanced Vehicles (EEV) limits and particulate emissions 90% lower than EEV standards. This engine family, in the gaseous version, has been developed in North America where it finds major application as compressor drives in gas gathering systems.

Among alternative fuels for internal combustion engines, natural gas — which in the distribution network is mainly methane (CH4) mixed with other hydrocarbons and nitrogen — is by far the most used fuel. However landfill and biogas are also increasingly used for this purpose.

Iveco Motors has given top priority to R&D in this field and almost all of its diesel engines have an equivalent spark-ignited (SI) version for gaseous fuels.

In the automotive sector, compressed natural gas (CNG) is used to power private cars and utility vehicles with permanent residence and predetermined daily routes, such as urban buses and refuse trucks.

For stationary applications such as generator sets or gas pipeline compressors, the gas supply from the network is reduced to the pressure required by the engine fueling system. Renewable fuels as landfill and biogas are generally used in power generation applications.

For CNG, Iveco Motors has developed one of the most environmentally friendly systems based on a multipoint electronic injection directly on the engine intake ports that ensures a stoichiometric combustion under variable engine load and speed. A three-way catalyst and lambda closed loop control system ensure that the exhaust gas will contain minimum amount of contaminants.

This technology has proven to guarantee emission levels far below limits internationally established for Environment Enhanced Vehicles (EEV).

In particular, NEF CNG engines show NO_x emissions 70% lower than EEV and particulate emissions 90% lower than EEV. This engine family, in the gaseous version, has been developed in North America where it finds major application as compressor drives in gas gathering systems.

Iveco Motors SI gas engines feature a very high reliability for their heavy-duty components — which are derived from the diesel engines — and a high efficiency similar to the diesel engine.

The multipoint electronic injection system has the potential for further evolution and its use can be extended to hydrogen and other alternative fuels available to the market in the future. ★

IVECO

2H Energy And Iveco Motors Power Generation Activities

By Luigi Vicarioli
Power Generation General Manager
Iveco Powertrain

2H Energy has long experience in the power generation field. The company was first started in Fécamp, Normandy, in 1947 as Houvenaghel Hennequin and the generating set manufacturer was purchased by Iveco in 2000.

In November 2002, the company, renamed 2H Energy, was transferred to a totally new plant in the new industrial area of Fécamp. The change in location, only 7 km (4 miles) from the original site, made it possible to retain practically all the skilled staff.

The present product range comprises a line of open, mobile and soundproofed generating sets with ratings from 30-3000 kVA. The generating sets are available both in the standard configuration — the majority of which are assembled in Pregnana Milanese — and in special configurations engineered in Fécamp according to customer specifications.

The company employes more than 415 people. Seventy are involved in R&D, 190 in manufacturing, 70 in service activities and the remaining 85 in administration and other duties.

2H Energy not only supplies gen-sets and electric boards, but also has the capability to provide turnkey energy solutions to the customer.

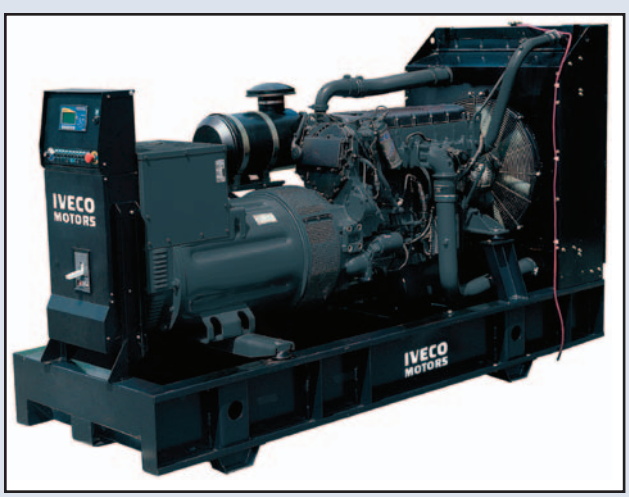
The competitive advantage the company has gained on the international marketplace was made possible by directly controlling 80% of the cost of the generating set structure.

The great majority of the engines come from Iveco Motors. Customers have the freedom to select other engine makes specially for power outputs beyond the Iveco Motor engine range of 1600 kW (2145 hp).

Canopies, base frames and other steel structures are made in-house in a separate building housing the steel sheet cutting, welding and painting department, that for environmental reasons have been separated from the main building.

Control panels are manufactured according to the know-how developed within 2H Energy which capitalizes on the long-standing experience the company has gained in this field.

The power generation systems are assembled and tested in the main building of the new plant, which also host the offices and the warehouse. Three soundproof test cells allow diesel and gas engine gen-sets to be tested under load. ★



Iveco's subsidiary company 2H Energy offers a line of open, mobile and soundproofed generating sets with ratings from 30-3000 kVA.

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