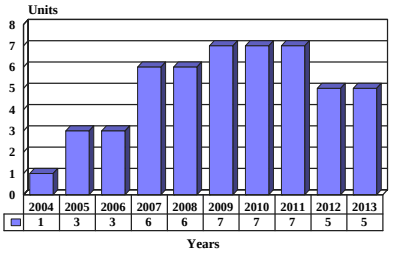
Eurodyn - Archived 2/2005

Outlook

- Marine propulsion remains the prime market arena at present
- Machine is expected to later garner duty in mechanical load drive and electrical generation arenas
- Sales have suffered because the machine has not been actively promoted by the three partners; recent sales, if any, have not been publicized



Orientation

Description. Small, highly efficient two-shaft industrial and marine gas turbine machine in the 2.5-2.7 MW class. (**Note:** *This gas turbine machine has also been referred to as the TM 2500 Eurodyn.*)

Sponsor. The Eurodyn machine effort has been sponsored privately by a three-firm consortium (see below) and has been supported by the European Union under the Eureka high-technology program (EU 159).

Contractors. The three major partners in the Eurodyn gas turbine machine program are:

- Rolls-Royce plc, Rolls-Royce Ulstein Turbine AS; Bergen, Norway.
- Turbomeca, Land & Marine Division; Bordes, France (Turbomeca is wholly owned by SNECMA).
- AB Volvo, Volvo Aero Corporation; Trollhättan, Sweden.

The machine is manufactured in Norway.

Power Class. 2.5-2.7 MW (3,352-3,620 shp).

Status. The Eurodyn gas turbine machine is production-ready.

Total Produced. As of the start of 2004, at least 12 preproduction and preproduction-standard machines are believed to have been fabricated. There are two engines installed in a ferry in Norway, and one preproduction-standard machine in a cogeneration plant in France.

Application. The main application of the Eurodyn is marine propulsion. No production-standard machines for electrical generation and mechanical load drives (pipeline and process industries) are believed to have been delivered as of the start of 2004.

Price Range. Estimated in 2004 dollars as follows: US$1.2-1.4 million for a turbine-driven electric power generating package; US$1.0-$1.2 million for a turbine-driven mechanical load drive package; US$925,000-$1.0 million for a marine gas turbine engine.

Competition. In the marine arena, the Eurodyn fits between the UTC PWPS ST18A and ST40, and below that of the Vericor TF40.

In the electrical generation arena, the Eurodyn's main competitor is the Kawasaki M1A-23.

In the mechanical load drive arena, one of the Eurodyn's main competitors is the Zorya-Mashproekt UGT-2500.

Technical Data

Design Features. The Eurodyn gas turbine machine has the following design features:

Compressor. The machine features a double-entry first stage compressor and single-entry second stage compressor with a radial turbine. Compressor pressure ratio is approximately 18:1. Mass flow approximately 25.3 lb/sec (11.48 kg/sec). Guide vanes are fixed.

Combustor. Six-can reverse-flow combustor configuration. Combustor is based on a two-staged, lean premix pre-vaporized (LPP) concept to provide low NOx over a wide operating range, enabling it to comply with the strictest emissions regulations. Fuel types are diesel, natural gas (CNG, LNG), and kerosene. The machine has dual-fuel injectors, and Venturi premixers for good atomization.

Turbines. Single-stage uncooled radial inflow-type HPT/gas generator. Two-stage axial free power turbine, rotating independently of the compressor shaft. TIT estimated at 1,832°F-2,012°F (1,000°C-1,100°C).

Accessories. An integral reduction gearbox designed with a variety of output speed options to match driven equipment. State-of-the-art microprocessor control system performs start-up and safety control and regulates the engine parameters. Electric or pneumatic starters are available.

Modularity. The main modules include the accessory gear, compressor, power turbine, and reduction gearbox.

Dimensions. The approximate dimensions and weight of the Eurodyn machine are as follows:

	Metric Units	**English Units**
Length	3.5 meters (3.5 m)	11.48 feet
Height	1.4 meters (1.4 m)	4.59 feet
Weight [(a)]	2,800 kilograms (2,800 kg)	6,173 pounds

[(a)] With reduction gearbox.

Performance. The Eurodyn machine for marine propulsion has the following performance parameters (ISO 15 conditions, no installation or gearbox losses):

	Application = Marine Propulsion/Drive	
	Metric Units	**English Units**
Output (Max. Continuous)	2,630 kW (2,630 kW)	3,527 hp
SFC	257 g/kWh	0.422 lb/hp-hr
Thermal Efficiency	32.9 %	32.9 %
Gas Generator Speed	33,000 rpm (33,000 rpm)	33,000 rpm
Power Turbine Speed	13,000 rpm (13,000 rpm)	13,000 rpm
Gearbox Output Options	1,050 /1,500 /1,800 rpm	1,050 /1,500 /1,800 rpm
Mass Flow	11.48 kg/sec (11.48 kg/s)	25.3 lb/sec
Exhaust Temperature	416°C	780°F
Emissions, Liquid Fuel	20 ppm NOx and CO	20 ppm NOx and CO
Emissions, Gas Fuel	Single-digit NOx	Single-digit NOx

The performance parameters of the Eurodyn machine for electrical generation and mechanical load drive are **estimated by Forecast International** as follows:

	Electrical Generation	**Mechanical Load Drive**
ISO Base Rating	2,370 kW (2 370 kW)	n.a.
ISO Continuous Rating	n.a.	3,353 hp
Heat Rate (LHV)	12,150 kJ/kWh	8,650 Btu/shp-hr
Exhaust Temperature	460°C	460°C
Turbine Speed	1,500 /1,800 rpm	N/A

n.a. = Not Applicable
N/A = Not Available

Variants/Upgrades

DURA. The Dual Inlet Radial Turbine (DURA) concept developed by Norway's (then) Kongsberg is applied in the Eurodyn machine, and DURA is sometimes used mistakenly to refer to this entire engine program.

TM 2500. Turbomeca documentation has listed the Eurodyn as the TM 2500 Eurodyn, although the Eurodyn name has been popularized in all publicity relating to this particular machine.

VT-2600. This is the designation used by Volvo to refer to the Eurodyn machine in its marketing efforts.

Program Review

Background. In 1990, there were reports that a new 2.5-3 MW gas turbine machine program had been under way for some time in Europe. The machine, then referred to as the Eurodyn (or, frequently at that time, Eurodyn 2000), has completed the final stages of development by Turbomeca in France, Ulstein (now part of Rolls-Royce) in Norway, and Volvo in Sweden. The new Eurodyn may be the first of what may be a family of new-generation, high-efficiency machines that make use of Turbomeca aviation turboshaft technology and the advanced technology of the Ulstein radial turbine machines.

The Eurodyn is described as a more efficient relative of present-day jet engines, having fuel consumption comparable to that of current diesel engines. The machine is intended to be capable of operating on a wide variety of liquid or gaseous fuels. Its size, weight, noise levels, vibration, emissions, and fuel consumption should be particularly appealing for high-speed marine applications.

The Eurodyn uses a Kongsberg-developed gas turbine concept, the Dual Inlet Radial Turbine (DURA). Efforts were aimed at developing a machine of 30-35 percent efficiency in two simple-cycle radial gas generator designs, the RT7 and RT27. The Eurodyn's power rating paralleled that of the RT27. In January 1989, Ulstein Holdings purchased the technology and patents related to the engine design of the Radial Turbine operations, which had initially belonged to Kongsberg. Ulstein claims that radial technology provides the potential for better fuel efficiency in a simple and rugged design with good performance at part-load (Ulstein Turbine AS is now part of Rolls-Royce plc).

The approximate revenue/risk-sharing partnership in the new engine program is as follows:

Firm	Share	Work Effort
Turbomeca	50 percent	Compressor section, auxiliary gearbox and accessories
Volvo	20 percent	Free power turbine, interturbine duct, microprocessor-based engine management and fuel control system
RR Ulstein	30 percent	Engine hot section (combustor and radial gas generator), integral/planetary gearbox

Applications. As a 2.5-3-MW industrial turbine featuring high efficiency, small size, and low emissions, the machine could find application in the power generation arena, especially in cogeneration installations; in such applications as commercial cogeneration for small- to medium-sized buildings; as a mechanical load driver for oil and gas pumping; and – most specifically – in the marine propulsion market perhaps for high-speed vessels such as catamarans. Even mentioned is the train/rail motive market, where one preproduction-series engine is being tested. The Norwegian Navy has expressed an interest in the engine as propulsion for a variety of surface vessels.

In addition, because of the Eurodyn's size and efficiency, it is suitable for armored vehicles and as a lightweight mobile electric power generator, the latter for such uses as the power source for electromagnetic weapons.

Ulstein UT 905. Ulstein built a 121-foot (37-meter) high-speed catamaran as a floating testbed for the Eurodyn; the vessel is powered by two Eurodyn turbines. Ulstein may eventually convert the catamaran for commercial service trials by installing seating for 225 passengers and by operating the vessel on a Norwegian route. The vessel completed a series of tests in 1994, and has been available for service since that time.

Funding

European government funding, if any, specifically pertaining to the Eurodyn gas turbine machine has not been identified.

Recent Contracts

No major identifiable military or commercial contracts specifically pertaining to the Eurodyn gas turbine machine have been awarded in the recent past. It should be noted that at least three machines have been installed.

Timetable

Month	Year	Major Development
Early	1990	Eurodyn effort revealed
Mid	1992	First prototype engine test conducted (in France)
Mar	1993	Second prototype engine test begun (in Norway)
Late	1994	Marine application test program started
Late	2001	Commercial production of engine launched
Dec	2001	First sale of Eurodyn reported
	2005-06	Electrical generation and mechanical drive applications expected to arise
Thru	2013	Continued production of Eurodyn machine projected

Worldwide Distribution

As of the start of 2004, an estimated 12 Eurodyn machines had been built in varying stages for concept verification and preproduction shakedown. Machines are known to have been installed in **France** and **Norway**.

Forecast Rationale

The team of Turbomeca, Rolls-Royce Ulstein, and Volvo Aero continues to seek viable applications for the Eurodyn engine in all marketplaces, but most specifically in the marine marketplace. Two proof-of-concept Eurodyns have been installed in a 37-meter high-speed catamaran built by Ulstein; that vessel could eventually form the foundation of a high-speed ferry market. In concert with that effort, Ulstein Propeller developed a dedicated lightweight compact gearbox for the marine application of the engine. The Eurodyn's very flat torque curve makes it ideal for twin-input/ single-output installations.

Use of the Eurodyn as propulsion/drive for rail locomotives may loom larger than previously thought. At about 3,550 shp and at a 32 percent efficiency level, the Eurodyn would be an excellent main power generator for high-speed trains worldwide.

In another arena, the engine could find application as a power generator for exotic applications such as very large artillery pieces or armored vehicles.

Given its high efficiency and low emissions, we believe that the Eurodyn machine will be able to compete in the power generation/cogeneration arena, especially in Europe. Other applications will arise in markets where the machine's small size will be a strong selling point, perhaps on offshore platforms.

One of the machine's strongest selling points is that it is designed to operate for 20,000 hours between overhauls for power generation applications, and for 9,000 hours between overhauls in a marine drive application – roughly three years of use between overhauls in both cases.

Despite that fact that activity at present with the Eurodyn appears to be at a low point, we continue to exercise cautious optimism in generating a forecast for that machine until greater activity with the program becomes evident. Overall, in the decade extending through the year 2013, we project that sales of the Eurodyn will be strongest in the marine power/ propulsion arena.

We project that 50 Eurodyn gas turbine machines will be built, 10 for the power generation/cogeneration arena, 32 for the marine propulsion/drive market, and eight for various mechanical load drive applications.

It should be noted that at the Eurodyn's power output, there are a large number of diesel engines that compete in its market arenas. In addition, after 2011, the Eurodyn should face strong competition from fuel cells, especially fuel cells ganged into blocks of 2-3 MW.

Ten-Year Outlook

The forecast chart below does *not* include possible use of the Eurodyn machine for propulsion/drive for rail locomotives or for other on-land vehicles.

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level				Good Confidence Level			Speculative			
Engine/Machine	**Application**	**thru 2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Total 2004-2013**
ROLLS-ROYCE/TURBOMECA/VOLVO (Consortium)													
EURODYN	DEV & TEST	9	–	–	–	–	–	–	–	–	–	–	–
EURODYN	GENERATION	1	0	1	0	1	2	2	2	2	0	0	10
EURODYN	MARINE POWER	2	1	2	2	4	4	4	3	4	4	4	32
EURODYN	MECHANICAL DRIVE	–	0	0	1	1	0	1	2	1	1	1	8
TOTAL PRODUCTION		12	1	3	3	6	6	7	7	7	5	5	50