## TWO EXAMPLES

How does Espe develop the syngas paradigm (a portmanteau that identifies the synthesis gas)? We can start from an industrial application concerning a drying system. 1.5 MW electric power, 3.3 MW thermal power and a preliminary challenge: the low water content. The thermal power feeds the drying system, 'digesting' 367 tons per year per module (the Chip50 powered by Tedom) at 10 per cent humidity level.
The second case is a textbook, a cogeneration plant fueled by wood biomass from conifer. 1.650.000 [illegible] generated by the mo[illegible] replace an agri oil [illegible]oiler and will warm up a greenhouse. The electric power is 735,000 kilowatts.

## WHAT IS WOODCHIPS

Biomass from agriculture and forestry, it consists of woody material cut up by a special machine (wood chipper). The calorific power of wood chips mainly depends on water content and specific gravity.



It's tailor-made for syngas the Tedom six cylinder - twelve liter able to generate electrical and thermal power by woodchips.

**Tedom Tw80 and Espe ChiP50**

# THE METAMORPHOSIS OF WOOD

The 12 liters Tedom engine which is fitted in the Espe ChiP50 module is specifically tested for syngas. Linear lambda sensor, Can open and a calorific value of 5.4 Mj/m$^3$ are among the key features of this system

## THE TW80 G5V AND THE ADVANTAGES OF MITTELEUROPA

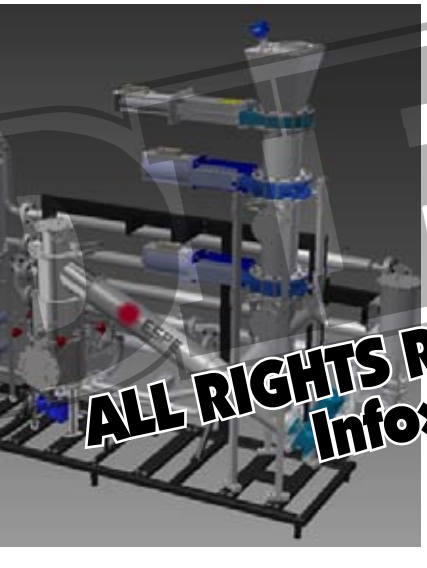
There is an automotive derivation at the root of this 12 liters which condenses the 'savoir faire' of Tedom, based on Liaz truck engines, bus calenders and rail traction. Specifically tested for synthesis gas applications, it has a simple architecture, with two valves per cylinder, is available either in aspirated or supercharged version, low or high pressure, with or without aftercooler, is calibrated 80 kilowatts and 509 Newtonmeter in standard version, and obviously has a low mep, being this a fixed speed application.
Alloys of high-tensile steel are used for rods and pistons in order to avoid the wear from corrosive agents such as hydrogen sulphide (H2S).
The shape of the piston has increased the volume of the combustion chamber to support the specificity of syngas from biomass combustion. The combustion is delayed to let more air in, with an integral movement of camshaft, valves and piston crown, which is cooled by a nozzle which injects oil from above the piston.
Tedom offers the Re-man (Re-manufacturing) program that provides units partially assembled with revamped components, taken from exhaust engines. Warranty covers twelve months.

A Tedom engine ready for [illegible]

CZECH PO[illegible]

[illegible] G5V Nx 86

| I.D. | |
|---|---|
| B x S [illegible] - S/B | 130x150 - 1,15 |
| N.cil.- dm³ | 6 - 11,94 |
| Maximum power kW/rpm | 80 - 1.500 |
| Maximun torque Nm | 509 |
| Mep at max power bar | 5,47 |
| Piston speed m/s | 7,5 |
| **RULES AND BALANCE** | |
| Dry weight kg | 920 |
| L * W * H mm | 1,716.8*832,1*1,301.8 |
| Mass/power kg/kW | 11,5 |
| Compression ratio :1 | 9,5 |
| Fuel input power at 100% kW | 276,6 |
| Valves per cylinder | 2 |
| Mixture | Stoichiometric |



It is tailor-made for syngas, has a linear lambda sensor and reads all Can parameters; it's the six-cylinder engine with two-liters cylinder displacement by Tedom that Espe chose to power the CHiP50 module. The term 'modular' fits the strategy of the installer, able to prepare up to six Tw80 motorized groups, [illegible] of which produc[illegible]50 kil[illegible] and th[illegible] system po[illegible] to 300 kW. Te[illegible] is configured [illegible] chip[illegible] set to lam[illegible] thanks to the sensor that allows to maintain a stable stoichiometric combustion. Concluding the premises, Tedom prepares the 12 liters with Can open interface, which handles a specific signals library and can be integrated with a transducer to transform Can open to Can J1939 able to read via plc all otherwise non-translatable parameters. The remote function displays the engine parameters - for example, pressure [illegible] temperature of th[illegible] k[illegible] nifold[illegible] n[illegible] ly such a[illegible] ng.

### How sem[illegible]tenance

[illegible] about cylinder head, that of Tw80 is divided into three parts to simplify maintenance and replacement and is interchangeable in pairs of cylinders. The injection is done through Altronic conventional coils: from 2015 Bosch-derived pencile coils will be available (currently only on natural gas engines), directly mounted on the spark plugs so to avoid cables and limit energy dissipation.
Espe provides the control logic and the global setup of [illegible]ystem, that is capable to [illegible]sform a kilogram of wood (preferably of coniferous and deciduous trees) at a 10 percent humidity level in a kilowatt. The injectors are made of inconel - a high – temperature, oxidation and corrosion resistant special alloy - and spray controlled amounts of oxygen which burns with the dried wood chips in the reactor, where the temperature reaches at specific points a peak of 1,200 °C, with a tolerance of 30-40 degrees. The gas



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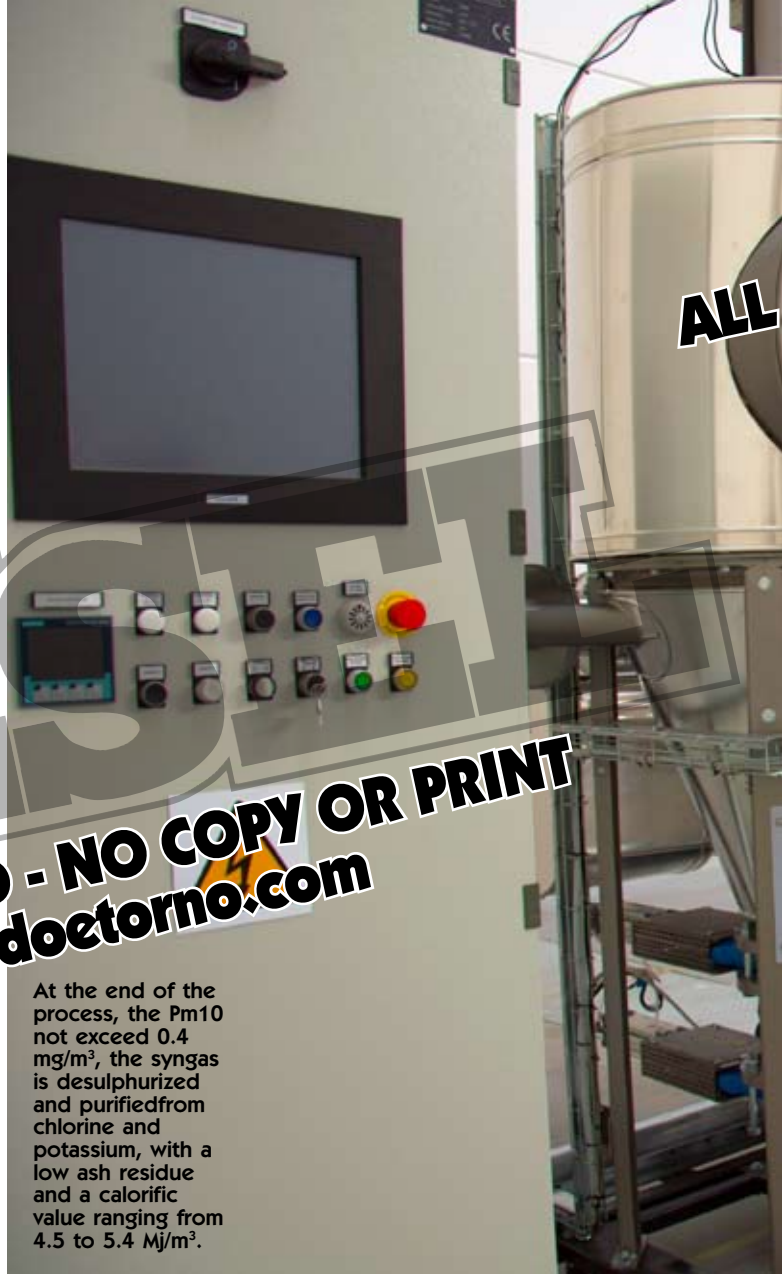
## ESPE AND THE ENERGY OF THE WORLD

'Profession energy' is the slogan of Espe, that has its roots and heart in the North East of Italy, branches all over the world and has just turned 40 years of activity (the company was established in 1974). There is not only wood in its portfolio. Espe Ro and Espe Energy manage photovoltaic projects and hydroelectric plants in the area of the former Warsaw Pact (five hydropower plants in Romania, in the district of Maramureş), Espe Sunparc America provides know how and turnkey projects in the field of solar energy for North America customers. At present, portfolio includes more than 200 peak MegaWatts (MW) in the photovoltaic [illegible] Espe provides all components both for roof and ground panels; the assistance contract may include the supervision service Esacontrol, with 24 hours a day remote tracking.
The diversification of the sources involved some other natural [illegible] Espe small wind turbines named from [illegible] kW generators and take advantage of the synergy with the Universities of Padua and Naples. Among the areas of installation is also Norfolk, in the east of the UK. Hydroc[illegible] in Italy and Romania. [illegible] construction and installation of Pelton, Francis and Kaplan turbines.

At the end of the process, the Pm10 not exceed 0.4 mg/m³, the syngas is desulphurized and purifiedfrom chlorine and potassium, with a low ash residue and a calorific value ranging from 4.5 to 5.4 Mj/m³.



## ALTRONIC DRESSES IN BLUE

Altronic, the American competitor of Motortech, provides Tedom with standard injection coils, those colored in blue, for instance, because the Czechs six-cylinder does not require the hi-charger red version. This solution is made possible by the combustion efficiency of Tedom and flexibility of Altronic, which provides ignition system individually placed on each cylinder, wiring and powered ignition unit. The permanent autonomous multipolar magnet alternator charges a capacitor, magnetically activated coils provide pulses to tap into that reservoir and release energy in sequence.



## TEDOM AND BOHEMIA: NOT ONLY CRYSTAL

Tedom crossed his story with Liaz (abbreviation of Liberecke automobilove zavody, 'Liberec car works') from the beginning. It's 1953, actually half a century after the birth of the progenitor of the Czech motor company named Raf (1907), but it is only in Czechoslovakia under Soviet tutelage that in Jablonec, near the border with Germany and Poland, that the production of engines takes off: from Karosa buses (1985), then transferred to Iveco bus, to stationary engines (1990) and to he acquisition of Liaz (2003).

At the moment the Euro 6 is not on the agenda, but Tedom gas units keep expanding in compressors, pumps, biomass and natural gas Chp, cng-powered automotive, locomotives, available in three ratings, 242, 265 and 310 kilowatts at 1,900 rpm with a torque of 1,600 Newtonmeter. Truck derivation, it has strong roots in bus market and a rich variety of Chp declinations (natural gas, biogas, lpg, diesel, biodiesel, syngas, pyrolysis and cbm - methane from coal). The six ratings for 6-cylinder 12-liter, from 86 to 212.7 kilowatts, are all natural gas powered.

Tedom is distributed in Italy by Rama Motori, based in Reggio Emilia.

## THE THREE WAYS OF DCL

The after-treatment to limit emissions in engines with rich mix or stoichiometric combustion is called three-way catalyst. Specifically, the abbreviation is Dc45-100 and the author's signature is that of the Canadian Dcl (Diesel controls limited), a global player in genset, co-generation and gas compression applications a[illegible] tertreatm[illegible] its syng[illegible]sion, compared to catalysts for natural gas, this device has two fundamental differences, the Pt/Pd (Platinum and Palladium) charge of the Twc catalytic converter - which compensates for syngas fluctuations in CO and NOx - and Osc (Oxigen storage capacity) altering the concentration of $CeO_2$ (cerium oxide) expanding the λ window.

The Dcl best seller are the catalytic converters fo[illegible] up to 520 [illegible] of [illegible] metal to preserve the integrity of honeycomb cells.

The main objectives of Dcl treatment are well known names for automotive diesel [illegible] and marin[illegible] c[illegible] (C[illegible]x, CO, [illegible] t[illegible] $CO_2$ appe[illegible] [illegible] known as formaldehyde, linked [illegible]



passes through a post-reformer and is processed to separate the carbon and other heavy chains into more elementary compounds through [illegible] crack. From 900[illegible] and ashes pass through [illegible] syngas/air exchanger (not air is reintroduced into the system), which reduces the gas temperature so to flow it safely into a primary filter, which separates ashes. Another syngas/water exchanger lowers the gas temperature up to 60/75 °C and a secondary filter separates condensation. After the downdraft fixed-bed Espe treatment, which conveys the wood chips and gas flows in the same direction, the particulate does not exceed 0.4 $mg/m^3$, the syngas is desulphurized and purified from chlorine and potassium, with a low ash residue and a calorific value ranging from 4.5 to 5.4 $Mj/m^3$, due to the higher methane density. **F.B.**