Micro-Combined Heat & Power Generation

Part 1 | Micro-cogeneration Technology

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TOTEM asja group

ITC International Training Centre

TOTEM ENERGY

A SUBSIDIARY OF ASJA GROUP

With a strong expertise in centralized energy generation Asja Group decided years ago to move into the business of decentralized energy generation with a strong awareness it will play an essential role in the years ahead.

Through the daugther company TOTEM ENERGY, Asja Group has become a specialist in Onsite Energy Generation products and particularly in Micro Combined Heat and Power generation.

Its flagship product is the TOTEM micro CHP.

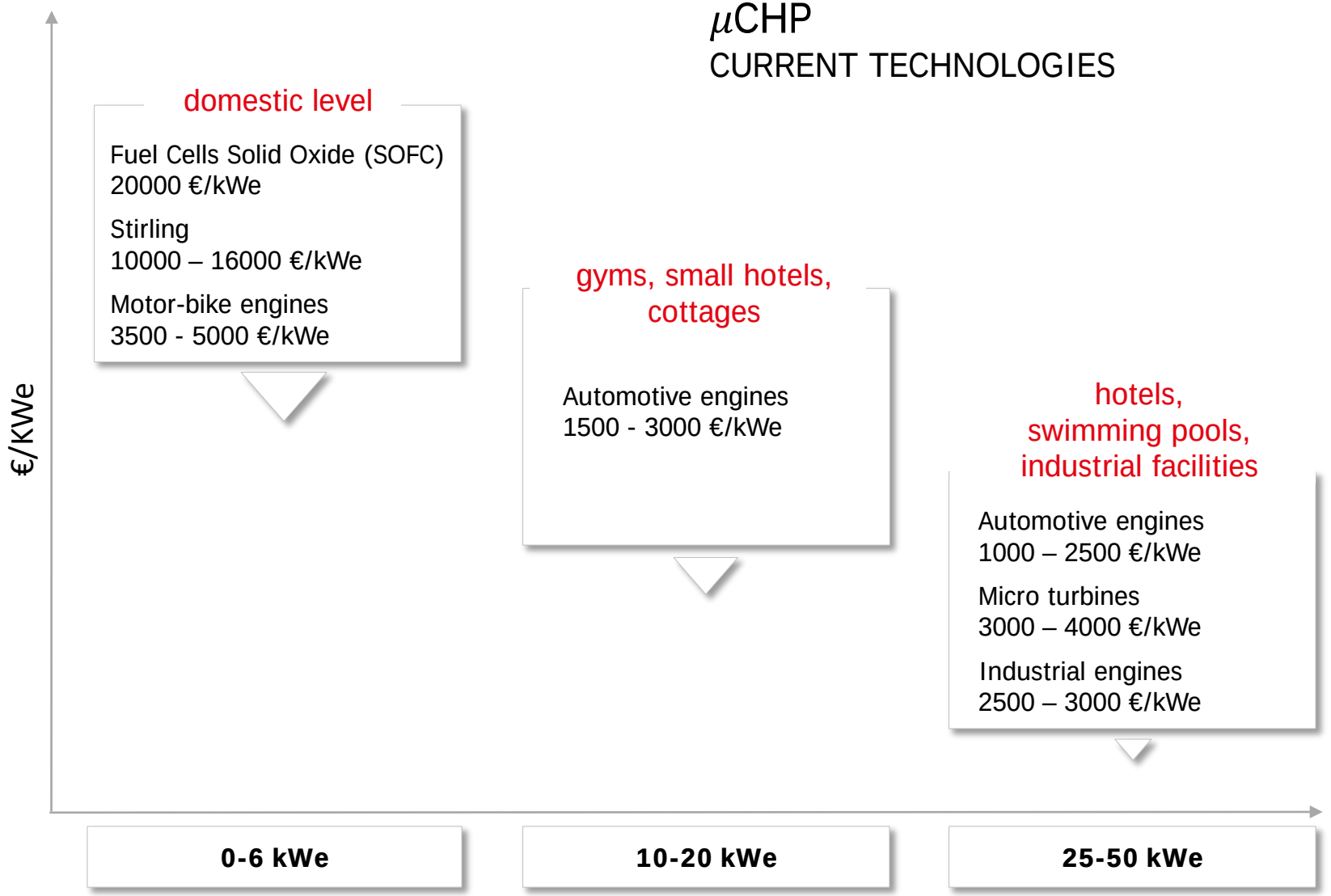
“Our energy environment is changing rapidly as Governments globally strive to make cost-efficient use of resources while enabling the emergence of a low carbon economy. Innovative policy is crucial to enabling the emergence of those technologies that will deliver this outcome.

Micro Combined Heat and Power (μCHP), a cost-effective and flexible low carbon solution that generates heat and electricity on-site, can support the transformation of the energy system and the achievement of relevant policy objectives, including environmental ones.

Widespread μCHP deployment can transfer a significant part of electricity generation at local level, creating significant benefits for the energy system and for consumers.”

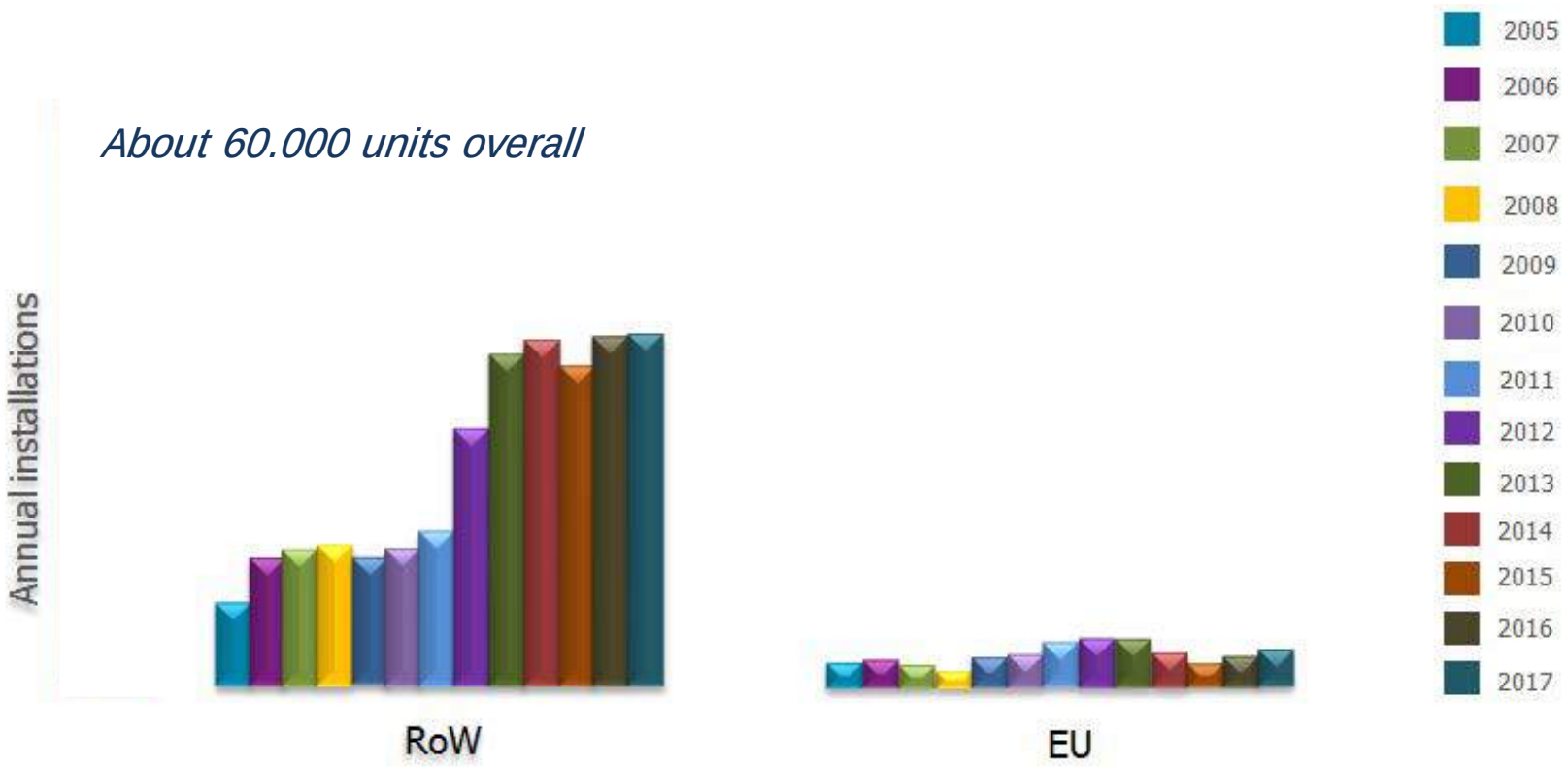
Supporting widespread uptake to achieve energy policy objectives
Ecuity Consulting LLP – March 2013

μCHP
CURRENT TECHNOLOGIES

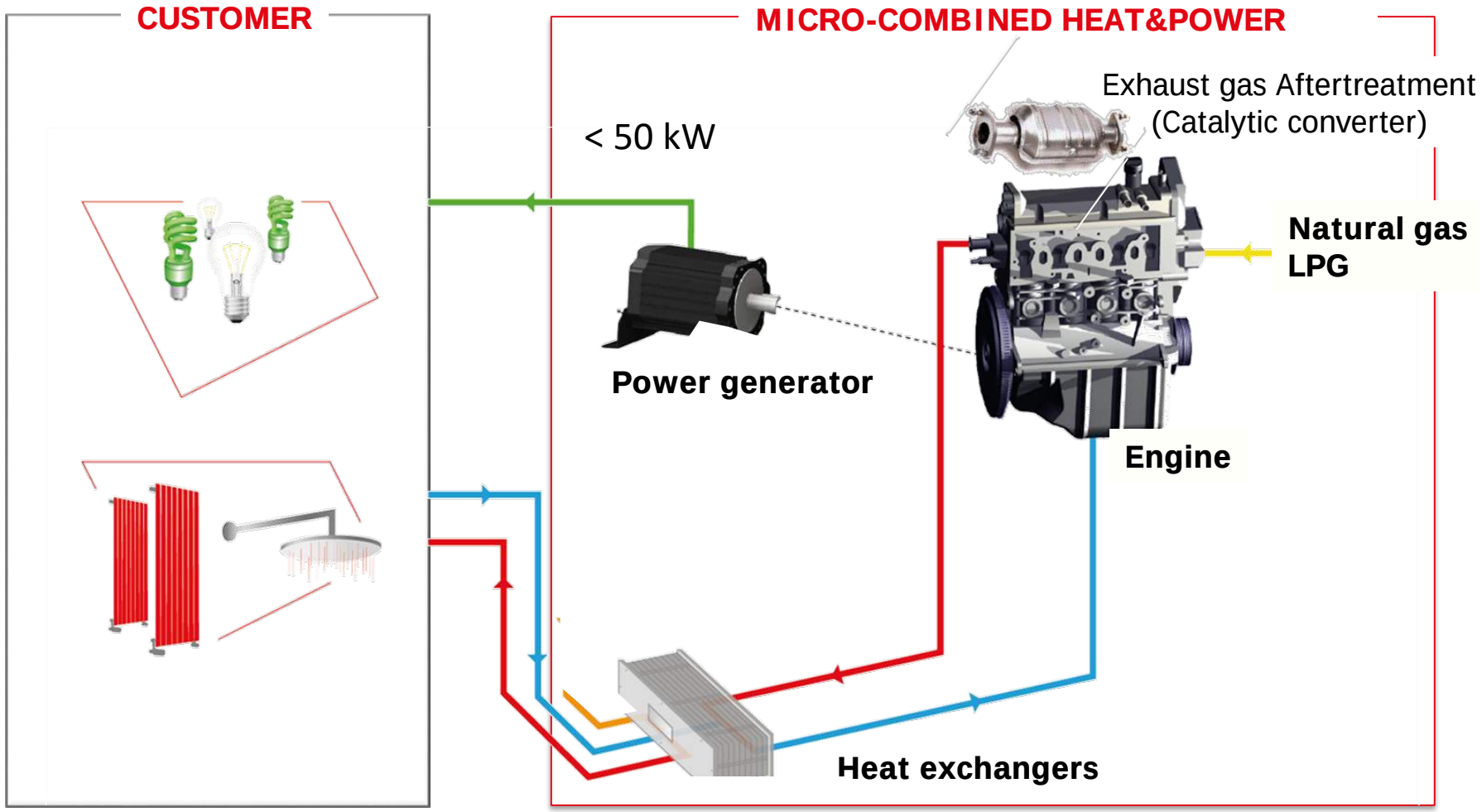


μCHP
IN THE WORLD

About 60.000 units overall



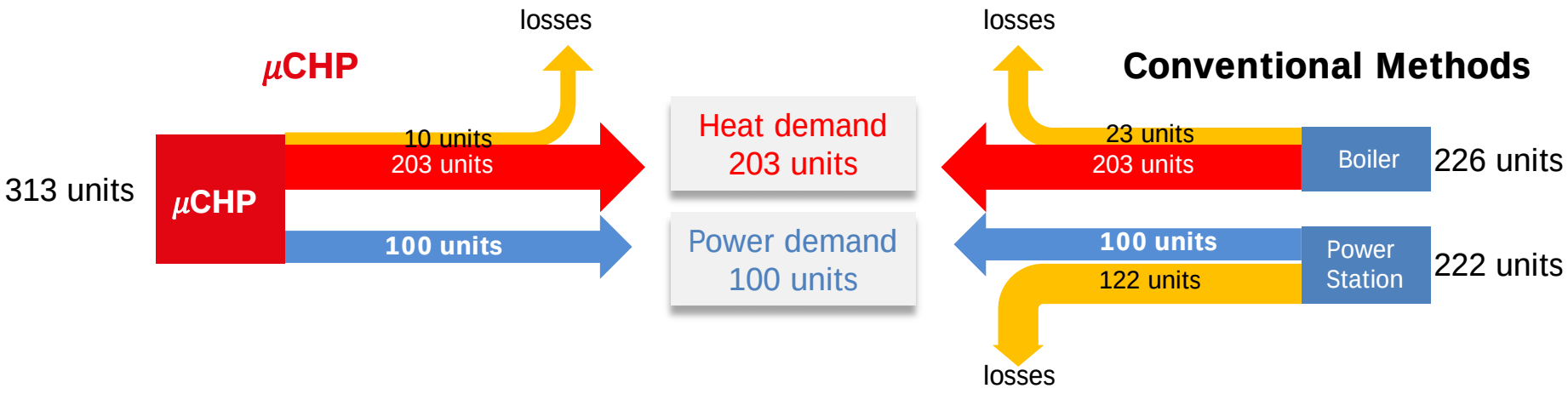
μCHP BASED ON INTERNAL COMBUSTION ENGINES



μCHP ENERGY SAVINGS

μCHP brings savings as the primary energy used is less than that required for the separate production of heat and power

Energy to produce 100 units electrical power demand



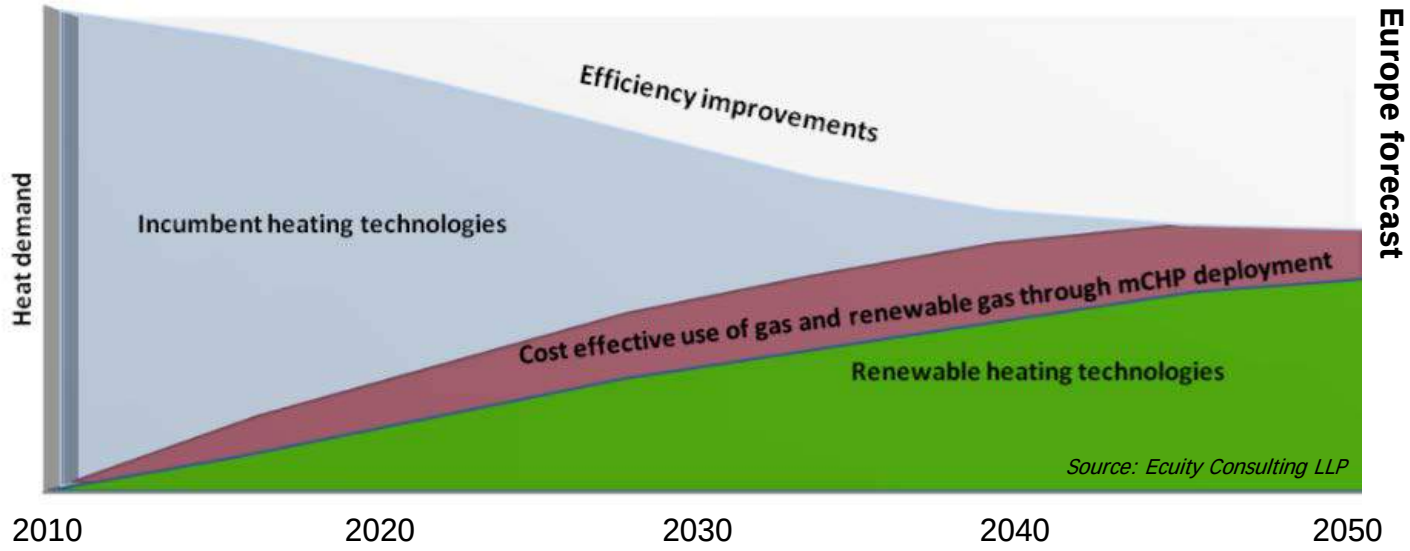
313 units of fuel input
303 units of delivered energy

30% saving

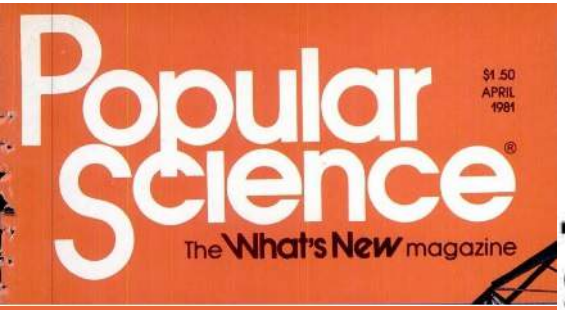
448 units of fuel input
303 units of delivered energy

μCHP AND BIOMETHANE

- Engine-based μCHP are flexible in terms of fuel type utilisation.
- Therefore, renewable gases like biomethane should be considered as the eventual fuel of preference for μCHP.
- Renewable gas fuelled μCHP would allow the technology to become part of the portfolio of renewable solutions to attain full decarbonisation of power and heating.



TOTEM
THE BEGINNING (1981)



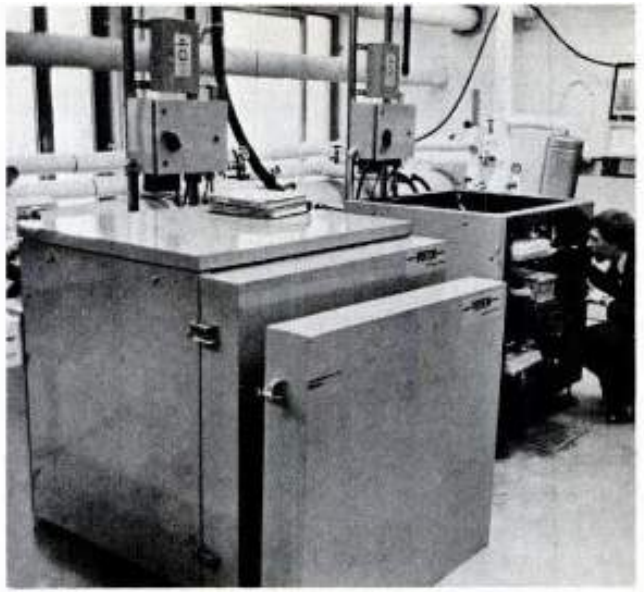
«...Now a small co-generation unit, developed and marketed by Fiat in Europe and called TOTAL Energy Module, or TOTEM, is available in the U.S. Through Brooklyn Union Gas Co. In New York City...»

Co-generator produces heat and electricity

Co-generation—burning fuel to produce both heat and electricity—is an old conservation idea that has recently been revived and hailed as an energy-saving alternative. Now a small co-generation unit, developed and marketed by Fiat in Europe and called the Total Energy Module, or Totem [PS, Aug. '77], is available in the U.S. through Brooklyn Union Gas Co. in New York City.

The heart of Totem is a 903-cc, four-cylinder internal-combustion engine—the standard engine in the Fiat 127 automobile. But Totem's engine has been modified to burn a variety of fuels, including natural gas, biogas, and propane, as well as methanol and other alcohols. The engine drives a 15-kW induction generator, producing electricity that can be fed into a utility grid or can supply power directly to a user's own circuits. Heat is extracted from the combustion process by circulating water through four primary and secondary heat exchangers, drawing heat from the generator, engine coolant, crankcase oil, and exhaust. The recaptured heat is used for domestic hot water, space heating, or, with the help of absorption water chillers, for air conditioning.

Totem has a fixed output ratio: Two-thirds is heat, one-third is electricity. Besides a 15-kW electrical output,



Compact Totem co-generators are 42" high, 41" wide, 46" long. Size will differ on U.S. version to fit through average door.

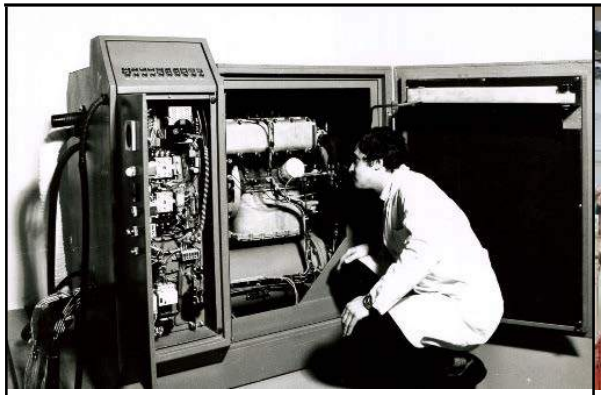
Totem generates 131,000 Btu/hr. That's enough heat to supply hot water for 16 apartments or heat four medium-size apartments.

With a price tag of about $10,000, Totem is well suited to apartment buildings, restaurants, hotels, hospitals, and a variety of industrial applications. Fiat hopes to introduce the Totem concept to the U.S. by selling 100–200 units.

For more information, write to Totem Project, Bob Ritacco, Brooklyn Union Gas, 195 Montague St., Brooklyn, N.Y. 11201.—*Jeanne McDermott*

40+ YEARS OF HISTORY

1977



Research and Development Center of Fiat designs the TOTEM, first microcogenerator in the world.

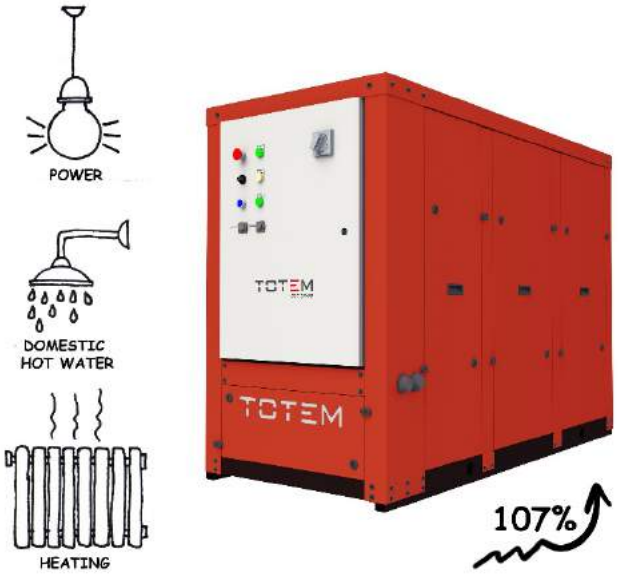
2015

Asja Group has developed TOTEM 2.0.

2018

TOTEM 2.0 is sold in Europe, North America and will be soon also in China.

TOTEM MICROCOGENERATOR
HEAT, POWER, EFFICIENCY



TOTEM microcogenerator

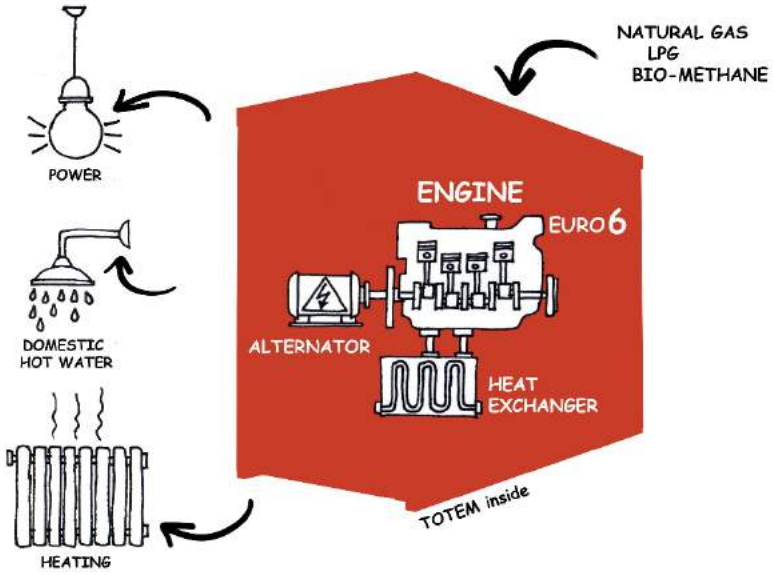
Innovative, 100% Italian, the evolution of the first microcogenerator in the world designed by Fiat Research and Development Center in 1977. TOTEM can be considered as a «boiler» that produces power in addition to the heat without harming the environment.

Efficiency 107%

TOTEM has an efficiency of 97% that increases up to 107% when it operates in condensing mode[1].

[1] heat recovery due to the condensation of water vapor in the exhaust gases

ADVANCED TECHNOLOGY



How does it work

The TOTEM brain is its Operating System that, thanks to the application of IoT technology, allows to manage every single unit remotely and also to enable cluster operation.

The TOTEM heart is a natural gas engine of FIAT 500 coupled with the alternator for power production.

Thanks to an efficient system utilizing a heat exchanger, the engine exhaust heat is totally recovered and provided to the customer.

TOTEM, WHY IT IS CONVENIENT

Savings

Allows savings up to 20% on the primary energy use[1] and financial savings up to 40% on the previous energy bills.

Incentives

Entitled to 65% of Ecobonus and White Certificates[2].

Low consumption

Extremely low consumption allows the client to repay it in 2 years or even less.

[1]compared to the equivalent weighted average consumption in Italy for the production of power and heat
[2]applies to an Italian market

TOTEM

FEATURES @ 50HZ

MODEL		TOTEM 10	TOTEM 20	TOTEM 25
Rated electric power	kW	10	20	25
Rated thermal power	kW	21,6 (25,2*)	41,9 (48,5*)	50,2 (57,6*)
Electrical efficiency	%	29,6	31,2	32,5
Total efficiency	%	93,6 (104,3*)	96,5 (106,8*)	97,8 (107,4*)
Engine		Fiat Fire 1400 cc		
Engine Control Unit		Magneti Marelli		
Fuel		methane, biomethane, LPG		
Fuel consumption (CH_4)	Nm^3/h	3,31	6,28	7,54
Emissions (NOx)@ 5%O_2	mg/Nm^3	≤ 10		
Emissions (CO) @ 5% O_2	mg/Nm^3	≤ 10		

Fiat Chrysler Automobiles engines and

Magneti Marelli technologies

Multi fuel

methane, biomethane and LPG

Reliable

with high level of efficiency over time

Short payback

2 - 4 years due to savings on energy bills (heat and power)

Indoor / outdoor

installation inside and outside

Operation

single and cascade operation; 50 or 60 Hz

TOTEM
FEATURES @ 60HZ

Model		TOTEM 25
Rated Electrical Power	kW	25
Rated Thermal Power	BTU kW	170,600 (195,200*) 50 (57.2*)
Net electrical efficiency (LHV)	%	31.2%
Total efficiency (LHV)	%	94.2 % (103.3%*)
Inlet water temperature	°F / °C	158 / 70
Engine		FCA Fire 1400 cc
Engine Control Unit		Magneti Marelli
Fuel		Natural Gas
Black-out start capability		Yes
Input power rate (LHV)	BTU (kW) Th/hr	270,760 (79.3) 2.71
Input power rate (HHV)	BTU (kW) Th/hr	300,214 (87.9) 3.00
Gas pressure requirement	W.C.	8
Emission settings (NOx)@ 5% O_2	lb/MWhr	< 0.10
Emission settings (CO)@ 5% O_2	lb/MWhr	< 0.10

* Referred to the input water temperature 95 F (35 °C)

- **Modulation**

  From 7.5 - 25 kW of electricity and 15 - 57 kW of heat. Electricity generated matches customer's demand without exceeding the required need

- **Black-out start**

  Working while grid failure or power outage. In black-out start mode TOTEM can be fueled either with natural gas or propane

- **Single phase ready**

  Through the 3+1 wires inverter it can supply three single phase sub grid at once

THE BEST RELATIONSHIP BETWEEN ENERGY PRODUCED AND EMISSIONS

NOx Emissions

Average of the boilers installed nationwide[1]

230 mg/Nm³

Limits for boilers in the Region of Lombardia[2]

178 mg/Nm³

Boilers Class 5 (lowest emissions)

≤ 61 mg/Nm³

TOTEM[3]

≤ 7 mg/Nm³

The TOTEM is the most efficient microcogenerator with the lowest emissions into the atmosphere thanks to the stoichiometric control of the carburation and to an efficient catalyst.

NOx emissions (nitrogen oxides) of TOTEM are:

- 25 times lower than the set limits established for boilers in the region of Lombardia, that are the stringent at national level
- 9 times lower than the boilers with the lowest emissions (class 5)

NOx is one of the most dangerous atmospheric pollutants for human health because they are the precursors to form other harmful substances (mainly PM).

[1] data from the ISPRA report 262/2017
[2] limits in Lombardia region for "Rehabilitation zones"
[3] quota attributed to the thermal energy; total emissions: ≤ 10 mg/Nm³

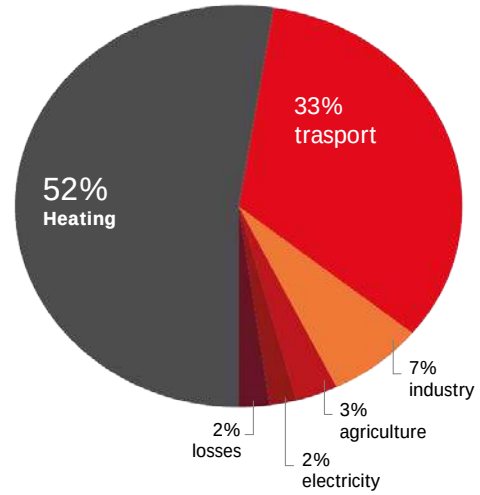
AIR POLLUTION

THE MAJOR CONTRIBUTOR IS HEATING

Heating

is responsible for more than half of the primary harmful emissions into the atmosphere

Polluting emissions by sector
Data by ISPRA



Harmful emissions

cause almost 80,000 deaths per year in Italy. (16,4% of the total)

13 times more
vs victims of asbestos disease

25 times more
vs road accidents victims

57 times more
vs work-related victims

Solution

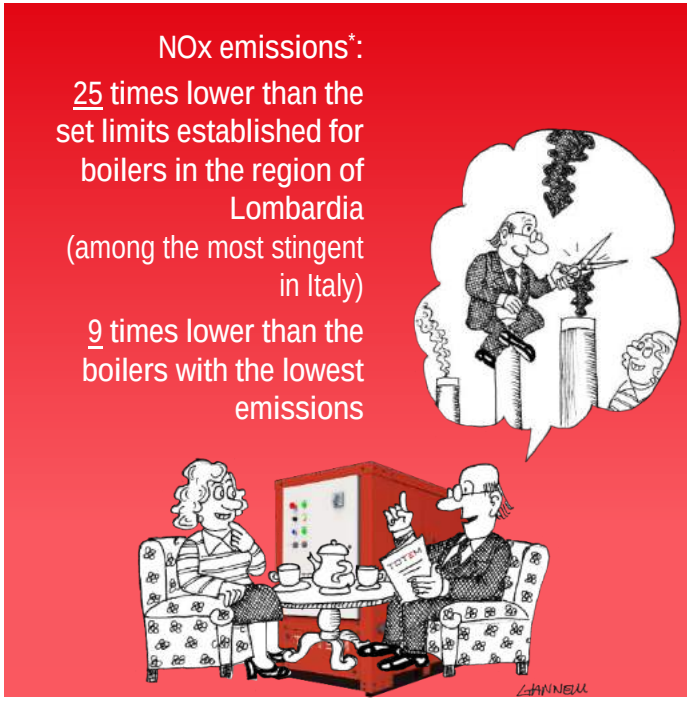
if the entire residential heat demand was produced by TOTEMs, every year it is expected...

30.000 less
deaths due to air pollution

7.500 ton less
of fine dust into the atmosphere

TOTEM is the most efficient and environmentally friendly solution to produce heat without harming the environment.

TOTEM MICROCOGENERATOR
AN ENVIRONMENTALLY FRIENDLY TECHNOLOGY

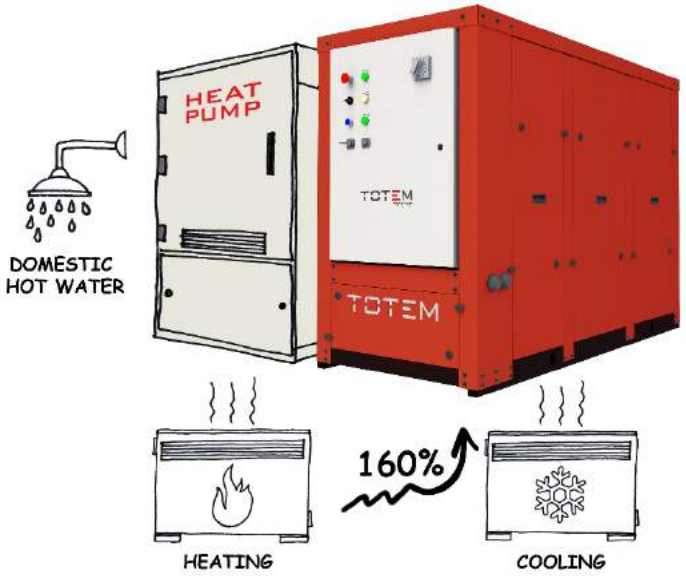


* NOx is one of the most dangerous atmospheric pollutants for human health because they are the precursors to form other harmful substances (mainly PM).

Microcogenerators can replace boilers in all cases where there is demand for electricity and heat (residential, tourist accommodations, wellness centers, healthcare, schools, public buildings, small/medium industry, Distribution,….).

If you cover the residential heat requirement (with exception of the single-family building) with TOTEM microcogenerators**,** in Italy, according to the Althesys study, 30,000 premature deaths per year due to atmospheric pollution would be avoided.

TOTEM FULL-THERMAL



Heat & cool at the best efficiency

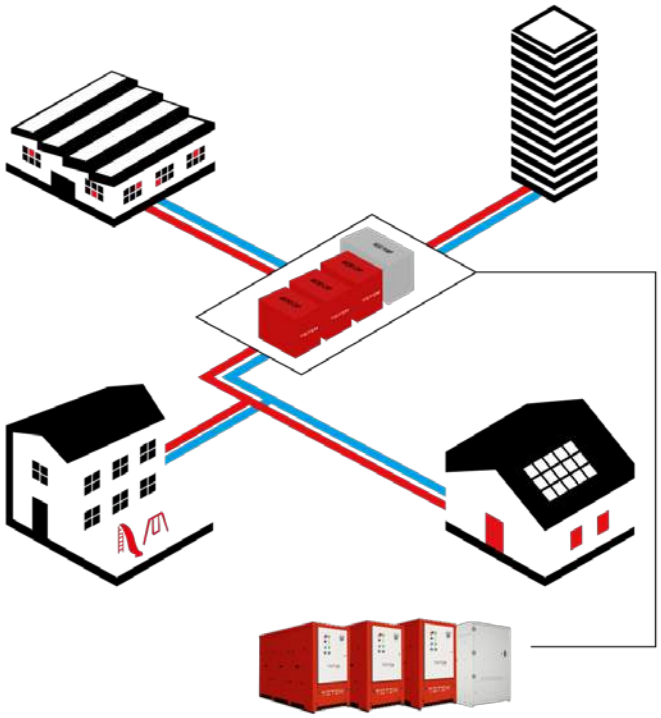
TOTEM Full-Thermal heats and cools taking benefit of the natural gas low cost as well as the heat pumps high efficiency. As a result, this system is extremely advantageous from the economic point of view compared to the use of «stand alone» electric heat pump.

INTEGRATION OF THE μCHP WITH THE HEAT PUMP

- The change in the Building Regulations by the end of the decade that will require any replacement of heating system to achieve a carbon reduction improvement vs. condensing boilers has the potential to establish a vibrant low carbon heating market.
- Such change would generate a level playing field for low carbon heating products, including μCHP .
- The power generated by the μCHP can be used by a Heat Pump to produce additional heat or to operate as a chiller.
- The combination of μCHP + Heat Pump can serve as a simple means of readily upgrading the existing stock of residential gas boilers and can integrate with legacy high-temperature heating systems (e.g. radiators, pumps)
- The global efficiency of the μCHP + Heat Pump systems can be as high as 160%:

  100 energy units of natural gas become 160 units of heat to the end user

TOTEM DISTRICT



TOTEM clusters distributed over the territory make energy platform efficient, flexible and with low emissions.

District heating & cooling

To meet local users' thermal needs (heating and cooling) by creating forms of «smart» district heating at the urban district level.

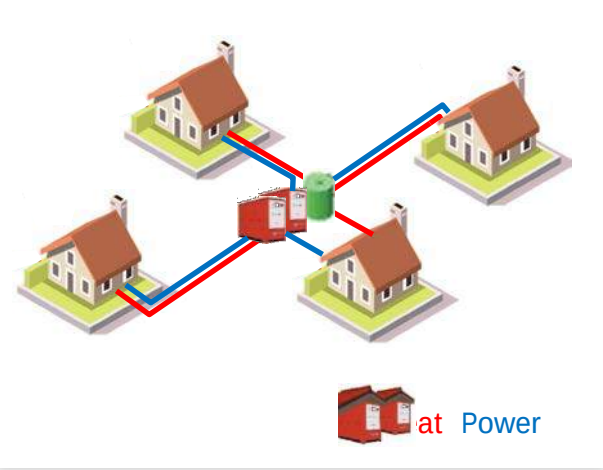
Digitized smart grid

To meet local power requirements by increasing the flexibility of renewable energy plants and optimizing the operation of the power grid through the access to the Dispatching Services Market(MSD).

Thanks to the intelligent TOTEM Operation System that makes energy platforms flexible and helps to control it quickly.

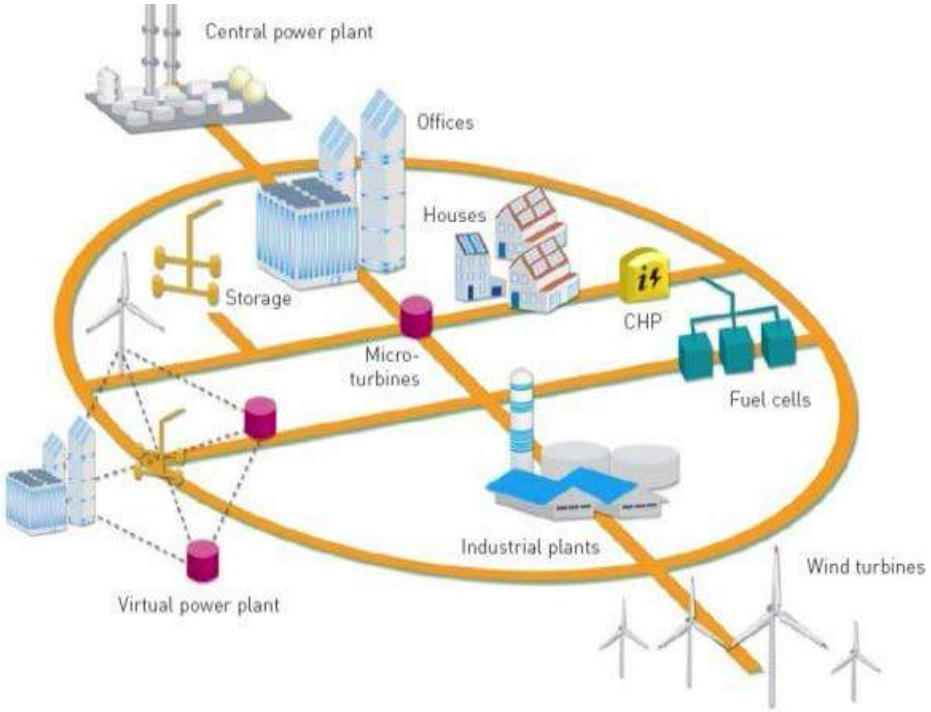
μCHP DISTRICT POWER & HEATING

- Aside from an ideal like-for-like heating replacement in individual properties, μCHP is well placed to operate in a modular fashion in a shared environment, benefiting from economies of scale. μCHP is an ideal solution for social housing or for a block of flats and community heating schemes.
- The modular deployment of μCHP may become the predominant commercialisation means as the decarbonisation targets become more stringent.



- Distributed μCHP clusters can jointly make a low emission District Power and Heating.
- In fact, μCHP can meet with flexibility the distributed customer demand of heat & power with emissions 9 times lower than the boilers with the lowest emissions and 20% less CO2 over centralized electricity generation.

μCHP SMART GRID INTEGRATION



With the deployment of smart meters and the smart grid coupled with improvements in energy storage, μCHP flexibility would generate innovative possibilities to incorporate the demand side more actively in power system operation (prosumers) with considerable benefits.

TOWARDS ENERGY 4D

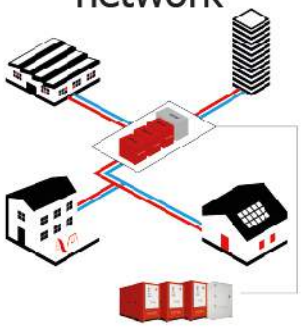
services for the
final clients

TOTEM
micro-cogenerator

FULL-THERMAL
TOTEM combined with
renewable sources
(heat pump or PV)

Distributed and Decarbonized generation
power and/or heat at high efficiency and with low emissions

services for the
network



TOTEM DISTRICT
integrated management
of energy platforms
thanks to the Smart
Operating System

District heating & cooling

Digitized smart grid
to optimize and balance the power grid

μCHP BENEFITS FOR THE USER

TOTEM asja group

- Economic benefits
  savings on energy bills
- Enabler for District Power and Heating
- Increased security in electrical supply
  (μCHP can also work in "island" mode in the event of blackouts)
- Operation in "Peak-shaving"
  to cope with high power demand for limited time periods
- Increased "Power quality"
  to ensure constant voltage and frequency to safeguard production processes

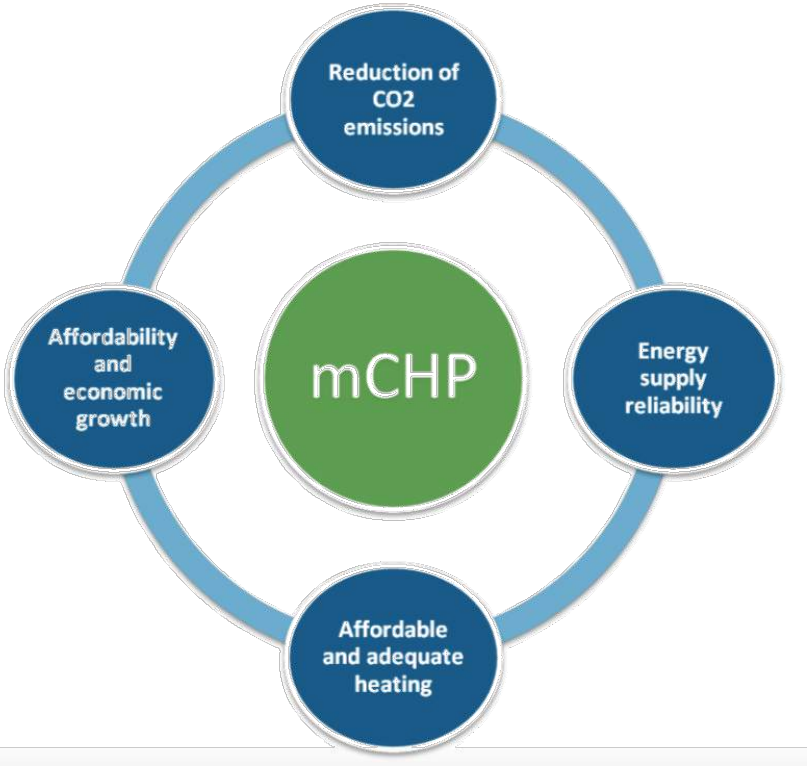
μCHP BENEFITS FOR THE ELECTRICAL SYSTEM AND FOR THE COUNTRY

- Widespread μCHP uptake could complement significant investment in centralised generation, or indeed transfer a considerable proportion of electricity generation from big centralised power stations to the local level

- About 7% of all generated electricity is lost when it is transported to consumers as a result of transmission and distribution losses. μCHP penetration would allow the efficient generation of electricity by alleviating losses of electricity

- In an environment that favours a more important role for local energy generation, μCHP is the most controllable distributed energy technology. The power output of μCHP can allow enhanced viability in local power generation as a result of its flexibility and natural fit with key renewable solutions and domestic electricity demand

μCHP BENEFITS FOR THE ELECTRICAL SYSTEM AND FOR THE COUNTRY



- Benefits for the balance of payments and decreased dependence on import of fossil fuels
- Reduced CO_2 and NOx emissions (reduced dead and health costs)
- Decreased occurrence of overload conditions in the transmission lines, with increased resilience of the electric grid
- Reduced transmission and distribution losses
- Encouragement of new energy providers liberalization of the energy sector

Micro-Combined Heat & Power Generation

Part 2 | Applications and Markets

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ITC International Training Centre

APPLICATIONS

TOTEM users

Wellness centers
swimming pools, thermal baths, spa

Tourist accommodations
hotel, resort

Healthcare
hospitals, polyclinics, nursing homes

Residential
condominiums

Public
schools, public buildings

Agricultural sector
dairies, sausage factories

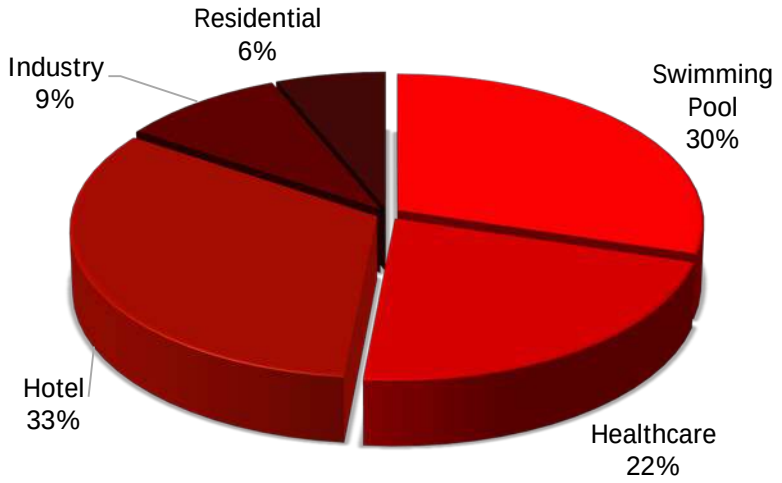
Distribution
supermarkets, outlet

Small/medium industry
production sites

Energy districts
micro grids for district heating and power generation

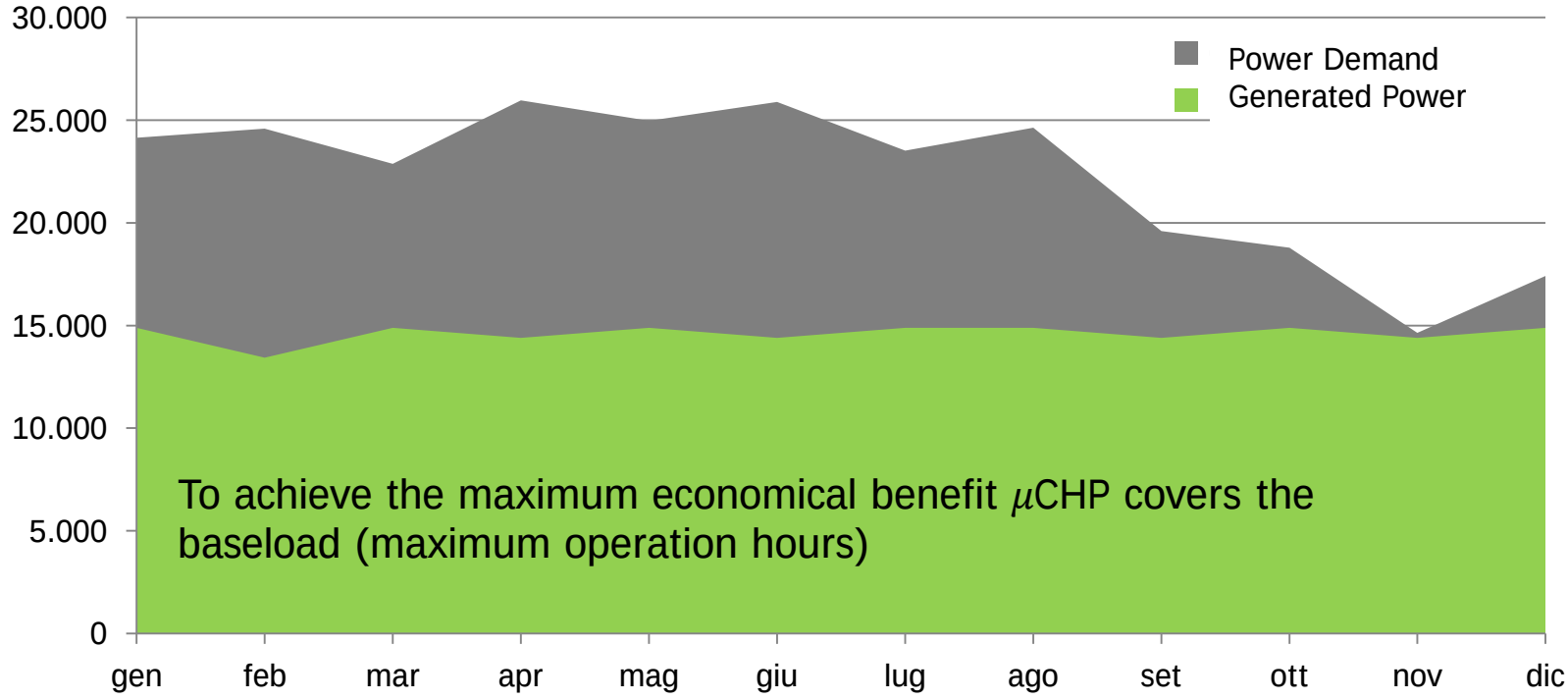
Utilities

APPLICATIONS IN ITALY



μCHP POWER DEMAND COVERAGE

EXAMPLE: SWIMMING POOL



BUSINESS CASE

SWIMMING POOL | ECONOMIC BENEFITS

Cost without TOTEM	
Heat (methane)	15.684 €
Power	43.442 €
Total (A)	59.126 €
Cost with TOTEM (1 x 25 kW)	
Methane and TOTEM operation	27.253 €
Power	14.560 €
Total (B)	41.813 €
Incentives to use TOTEM	
Tax deduction (C)	4.290 €
Annual gross savings (A-B+C)	21.603 €
Cumulative gross savings in 15 years	324.045 €
Cost for TOTEM (with installation)	64.800 €
Cumulative net savings in 15 years	259.245 €
Payback (years)	3,0

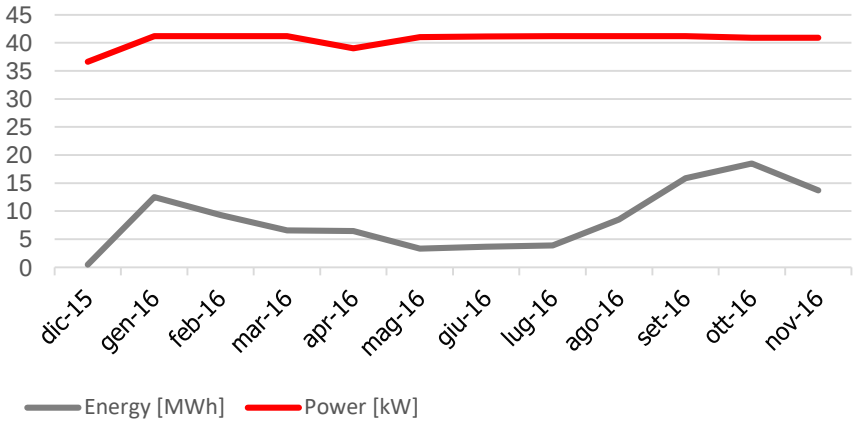
* With reference to energy prices applicable to Italy. TOTEM unots w/o black start feature.

BUSINESS CASE

HOTEL | ECONOMIC BENEFITS

Cost without TOTEM	
Heat (methane)	66.524 €
Power	88.800 €
Total (A)	155.324 €
Cost with TOTEM (2 x 20 kW)	
Methane and TOTEM operation	87.251 €
Power	39.220 €
Total (B)	126.471 €
Incentives to use TOTEM	
Tax deduction (C)	5.963 €
Annual gross savings (A-B+C)	34.816 €
Cumulative gross savings in 15 years	522.240 €
Cost for TOTEM (with installation)	91.740 €
Cumulative net savings in 15 years	430.500 €
Payback (years)	2,6

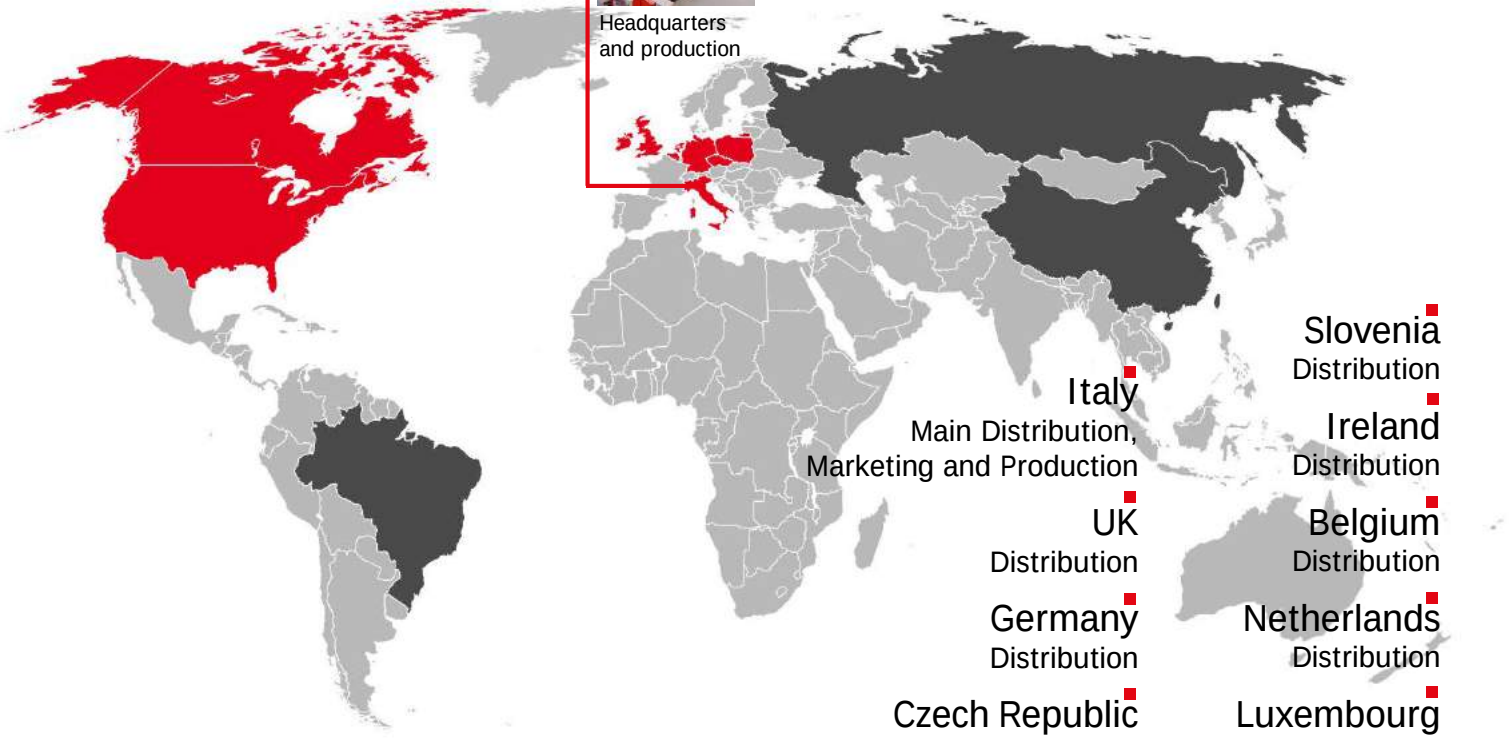
Montlhly Performance



* With reference to energy prices applicable to Italy. TOTEM unots w/o black start feature.

TOTEM ENERGY WORLDWIDE

Headquarters
and production



Italy
Main Distribution,
Marketing and Production

UK
Distribution

Germany
Distribution

Czech Republic
Distribution

Slovenia
Distribution

Ireland
Distribution

Belgium
Distribution

Netherlands
Distribution

Luxembourg
Distribution

USA & Canada
Distribution

China
Business
Development

Brazil
Business
Development

Russia
Business
Development

MARKETS
GERMANY

Drivers

- CHP supportive policy development last 15 years
- From 2012 - 2015 in the range from 10 - 50 kWel 6.937 units were installed (192 MW el)
- BAFA incentives (major CHP incentive in the country; incentive amounts up to €4.375/unit)
- KWKG incentives (€ 0,04/kWh for self consumption in addition to TOTEM generation savings or € 0,08/kWh for selling electricity back to the grid)
- CHP awareness and acceptance by end users are the highest in GE among other EU countries

Opportunities

- In 2016 the last amendment has been launched to CHP law to make conditions more favorable to self consumption
- Need to replace mCHP units installed 10 - 15 years ago

MARKETS
UNITED KINGDOM

Drivers

- Increasing power prices
- UK has set a long-term carbon emissions reduction goal of 80% by 2050 favoring the use of high-efficiency technologies such as CHP.
- Building regulations 2010 (legal binding requirements); micro CHP is one of the technologies that is allowed by LZC (Low and Zero Carbon Energy Source) to meet building regulations
- London is setting more stringiest air quality standards: all plant to meet a NOx emission limit of <50 mg Nm3 at 5% O2 (dry gas) [TOTEM meets it; EC Power – no]

Opportunities

- Up to 10 million new homes will be needed by 2050
- Existing stock needs boiler replacement; micro CHP is ease of retrofitting

MARKETS
CZECH REPUBLIC

Drivers

- Nuclear and Coal are still dominant in supply
- European Commission has approved support scheme for CHP in CZ for the period from 01.2016-12.2020
- Green Bonuses are officially in place and active (Payback 4 – 7 years)
- EU Investment bank is investing in improvement of district heating of Czech Republic
- Long heating season

Opportunities

- Government wants to stop using coal – need to replace with non-coal technology
- Existing stock needs boiler replacement; micro CHP is ease of retrofitting : opportunities in Building and housing sector
- Subsidies for energy efficient projects (building renovation)

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BALKANS

Drivers

- Efficient urban planning - migration to urban areas are increasing, need to improve energy efficiency and security in new building and retrofits.
- Decrease energy import - promoting energy efficiency gives possibility to meet energy needs without expensive import.
- Reducing - GHG gases and other environmental and social impact.
- More and more adopting incentives to support RES and energy efficiency (ex. Bosnia and Herzegovina, the guaranteed prices for the purchase of electrical energy from facilities using RES and CHP).

Opportunities

- Excising opportunities for large CHP and biofuel
- Micro CHP without incentives bring to 7-8 years payback
- Additional study needed and possible pilot projects

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CANADA (60 Hz)

Shown are the **best locations for Micro CHP** based on payback, policies, net metering rules, discounted natural gas prices, length of heating season, emissions regulations and an experienced dealer network.

Drivers

- Rising energy cost (not in Ontario but in other states, ex. In Alberta electricity has doubled during the last year)
- Long heating season (up to 10 months)
- Advanced CHP technology is more accessible for properties
- 7% of electricity is produced using cogeneration
- Recurrent grid outages
- Need to reduce grid demand and improve infrastructure cost and time effective

Opportunities

- Real estate investment companies
- Residential/commercial applications/multifamily houses

MARKETS
CHINA

Drivers

- Away from coal – Eco-friendly equipment is welcomed in China
- Chinese government is taken serious actions to pollution issues
- Local players are entering the market but they bring an equipment with higher emissions (≈ 70 mg/NOx)
- Subsidies in Shanghai (Payback 3 – 4 years)
- Long heating season

Opportunities

- Lots of opportunities in the Hotel industry
- Existing partner that has current clients' database
- Pilot projects are launching in China

MARKETS
AFRICA

Drivers

- Growing economy, LNG and LPG network and reserves
- Existing projects of RES and energy efficiency
- Support country's economic growth (power and heat supply for textile, food, chemical and commercial plants)
- Urgent need for energy supply Limited access to electricity
- Avoiding distribution losses which represents 10-12%
- Creating reliable electricity supply

Opportunities

- Residential buildings, hospitals and schools
- Small commercial industries
- Most attractive states: Morocco, Jordan, Egypt and South Africa

Thank you for your attention

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