

# WASTE HEAT RECOVERY INDUSTRIAL APPLICATIONS

## UAE CASE STUDY

**ENGIE**  
Solutions



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ENGIE Solutions UAE

## **01 WASTE TO HEAT RECOVERY (WHR)**

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## **02 WHR CEMENT INDUSTRY CASE STUDY – UAE**

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## **03 ENGIE DECARBONIZATION SERVICES**

01

## WASTE TO HEAT RECOVERY

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# WASTE HEAT

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Waste Heat is a major contributor of greenhouse gas emissions and global warming

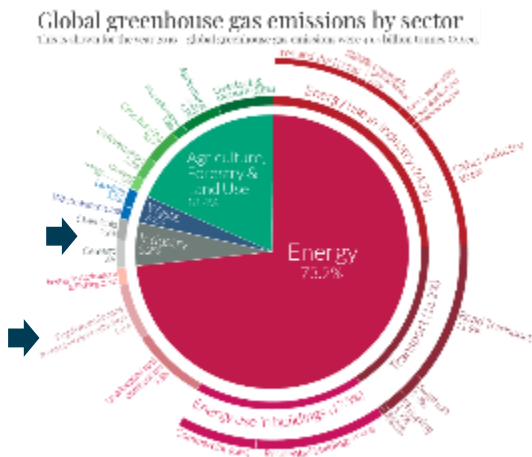


According to the US Department of Energy, up to 50 percent of the energy from all fuels burned in the U.S. ends up in the atmosphere as waste heat.

Waste heat sources: flue gases from a heat source such as gas turbines, cement kiln, burners or diesel generator.

# WASTE HEAT

Waste Heat is a major contributor of greenhouse gas emissions and global warming



11% of the global greenhouse emissions comes from direct emissions of cement and petrochemical industries as well as from energy production

# WHR DESCRIPTION

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**Waste Heat Recovery is a process optimization measure which has a massive impact in heavy industry's decarbonization strategies**



Waste heat recovery is the practice of capturing hot gas exiting industrial equipment and transforming into power, heat, etc.

The feasibility of recovering of hot exhaust gas highly depends largely on the gas temperature and mass flow

# WHR APPLICATIONS IN INDUSTRY

## Sectors, Heat Source & Applications

### Sector

- Metals
- Cement
- Ceramic
- Glass
- Oil & Gas
- Generation
- Processing
- ...

### Heat Source

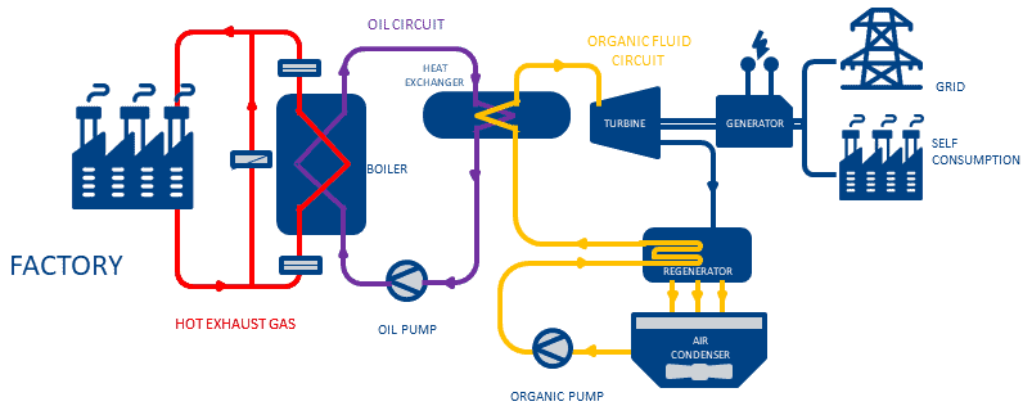
- Furnace
- Kiln
- Boiler
- Oven
- Generator Set
- Gas Turbine
- Thermal Oxidizer
- Incinerator...

### Applications

- Air Heating
- Drying
- Building heating
- Water
- Process feed water
- ORC Power Generation
- Thermal Oil
- Thermal Transmission
- ORC Power Generation
- ....

# WHR-ORC HOW IT WORKS

## Wasted Heat Recovery Process-Flow





# WHR-ORC HOW IT WORKS



# ORGANIC RANKINE CYCLE ADVANTAGES VS STEAM WHR

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Water is scarce and costly and therefore water-cooled systems exhibit significant operational costs.

High temperature ambient conditions are not optimal for air cooled steam condensation.

High dry bulb temperatures limit air cooled steam condenser performance in relation to wet bulb.

Organic fluid thermodynamic cycle exhibits a lower enthalpy drop than steam.



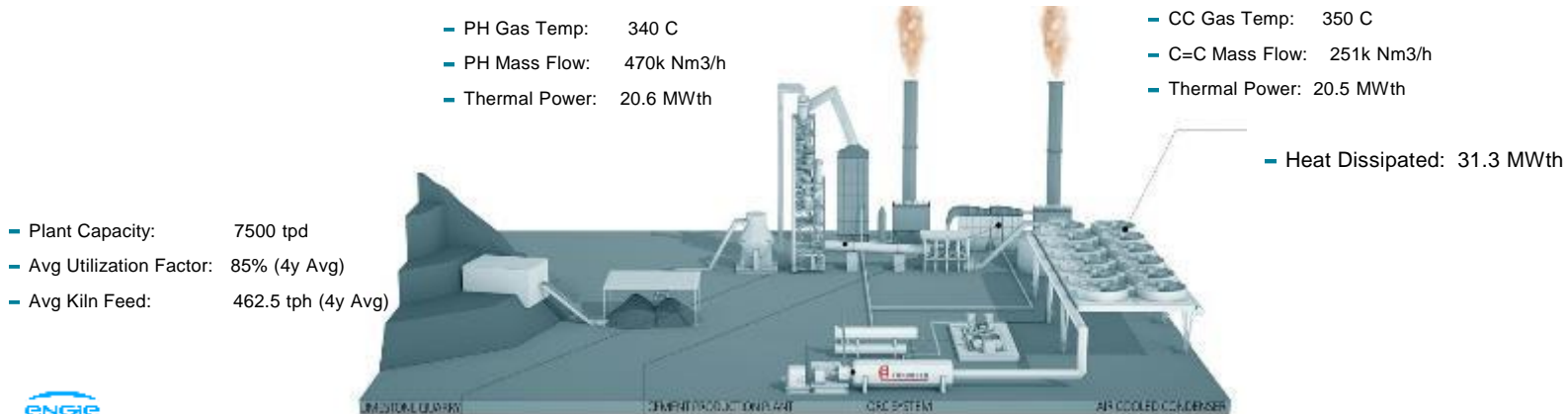
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# CEMENT INDUSTRY

CASE STUDY - UAE

# THE CEMENT FACTORY: TWO MAJOR HEAT SOURCES

Waste Heat Recovery is a process optimization measure which has a massive impact in heavy industry's decarbonization strategies



# ORC WHR DESCRIPTION – CEMENT FACTORY

## ORC-WHR Main Equipment / Heat - Power Generation Description

### System Main Equipment

#### Heat Recovery System

Heat Recovery Boilers (PH / CC)  
Damper System

#### ORC Cycle

Turbine  
Generator  
Condenser  
Regenerator  
Heat Transfer Fluid Heat Exchangers

### System Interface to LEC

PH: Downcomer Isolation Damper  
CC: Exhaust Isolation Damper  
Dust conveyor systems (non-critical)  
Point of Common Coupling: Cement  
Plant Electrical Substation

### Power Generation

#### Design Condition Capacity (Avg. 28C)

- Gross Power: 9.80 MW
- Self-Consumption and Losses: 1.03 MW
- Net Power: 8.78 MW

#### Expected Power Generation

- @ Minimum heat: 64.8 GWh
- @ Average Heat: 67.3 GWh

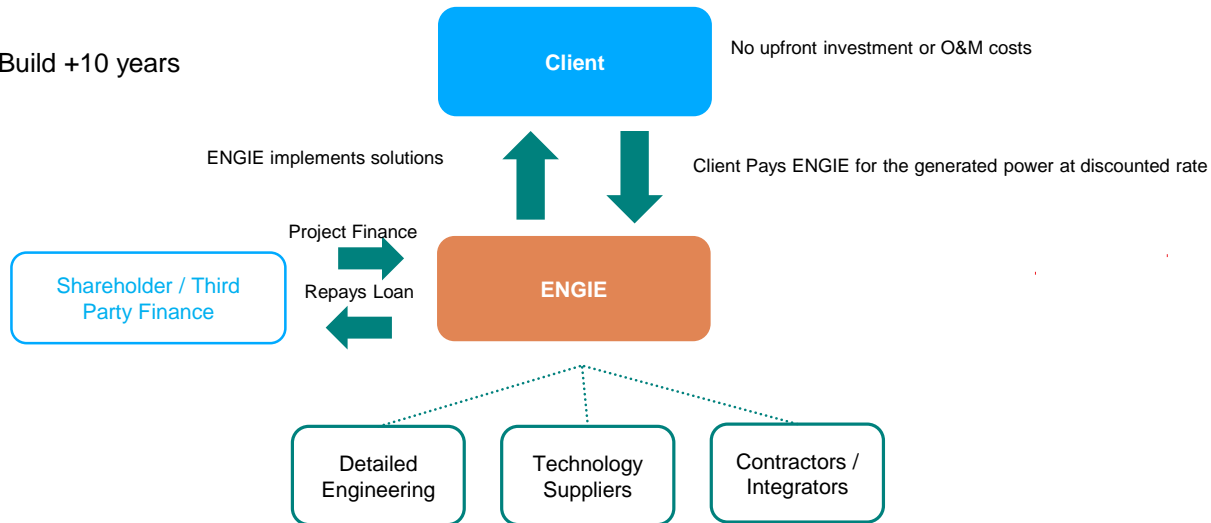
# WHR-ORC PROJECT INFORMATION

Name of project:	CEMENT COMPANY WHR-ORC
Project :	<ul style="list-style-type: none"><li>• 9MW Capacity WHR-ORC</li><li>• Design &amp; Build: 1.5 years</li><li>• O&amp;M: 10 years</li></ul>
Commercial arrangements:	<ul style="list-style-type: none"><li>• BOOT/PPA between Cement Company &amp; ENGIE with buy out option</li><li>• Agreed Discount Rate over Utility Tariff</li></ul>
Total investment & O&M cost (10 yrs)	<ul style="list-style-type: none"><li>• &gt; 25M USD</li></ul>
WHR annual power generation	<ul style="list-style-type: none"><li>• &gt; 60 GWh / year</li></ul>

# BOOT /PPA CONTRACT

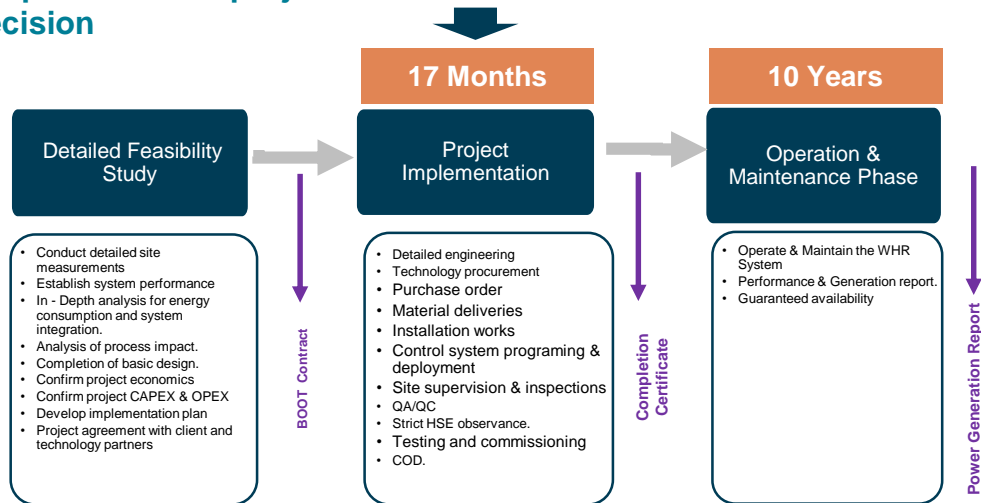
## BOOT Model

Contract duration: Build +10 years



# WHR PROJECT ROADMAP

Project timeline depends on the project size and client decision





# DETAILED FEASIBILITY STUDY & BOOT CONTRACT REVIEW

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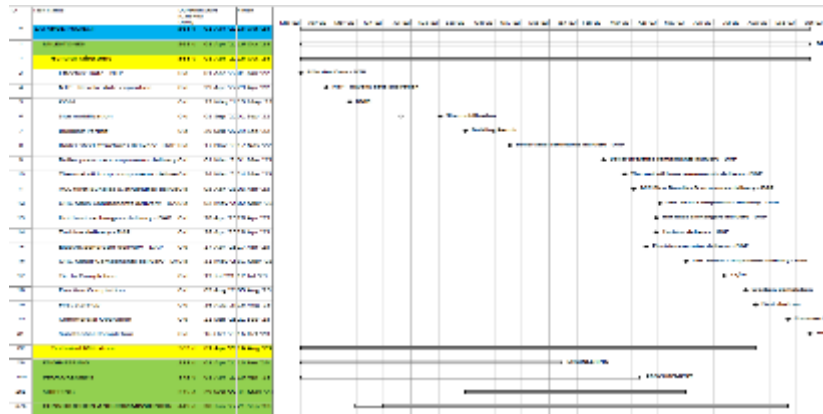
## Technical, commercial & financial study

- Heat Sources & Output
  - WHR System Capacity
  - Basic System Design
  
  - Equipment specifications & BoQ
  - Vendors
  - Capex & opex budgeting
  - Project implementation plan
- BOOT financial model
  - Discount rate / buy-out option values
  
  - BOOT agreement
  - EPC agreement
  - Logistics, freight, insurances
  - Business outlook / Creditworthiness
  - Project risks & insurances

# WHR PROJECT IMPLEMENTATION PLAN

The project comprises a packed set of activities over a period of 17 months

- Detailed Engineering & Permits Mgmt
- Equipment Components Procurement
- Manufacturing (offshore)
- Freight & Customs Mgmt
- Civil Works
- Equipment assembling & erection
- Integration & controls
- Testing & commissioning



# ENGIE ENGINEERING AT ITS BEST

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## Some of the Engineering highlights

- Erecting two heat exchangers at 65-70 m height
- Tap-in process to be completed within one week
- Thermal-oil circuit with total length of xx m crossing around cement plant
- Custom-made turbine of xx capacity
- Sea and land transportation of major equipment ...
- Building on-site ORC plant comprising turbine, generator, regenerator...

# PROJECT RISKS

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## Some of the Major Risks

- Heat output availability - production activity & business outlook
- Permits & approvals
- Delays on delivery / installation
- High-risk construction activities (HSE)
- Payments – Client Creditworthiness & Guarantees

# ENGIE PROJECT TEAM EXPERTISE

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ENGIE brought a team of international and local experts

- WHR system
- Cement industry
- Civil, mechanical, electrical and controls
- Project management
- BOOT / PPA contract – finance, legal & commercial

# WHR PROJECT: CLIENT MAIN BENEFITS

## Energy Cost Savings

- > 60 GWh / year consumption reduction from the grid
- > 9M USD in cost savings over 10 yrs. contract (due to lower rate from WHR power generation)
- > +60M USD in cost saving over WHR system lifetime

## Decarbonization

- > 30,000 CO2 Tons / year
- > 300,000 CO2 Tons 10 yrs. contract
- > 600,000 CO2 Tons 20 yrs. lifecycle

## Operations

- Minimum interference with production process

03

## ENGIE DECARBONIZATION SERVICES

# ENGIE SOLUTIONS

Turnkey and tailor-made offers to support the energy transition

**40,000** (3500 GCC)  
skilled & engaged employees

**23 GW**  
of distributed energy  
infrastructures

**5MtCO<sub>2</sub>**  
Avoided for our customers

**€9.5bn**  
Turnover 2021



ENGIE Solutions is firmly rooted in the GCC region, delivering the right infrastructure management and energy optimisation solutions to our customers right here through local resource.

Our global presence combined with local expertise enable us to provide customers with the right, locally-relevant solutions that yield real business results.



# ENGIE SOLUTIONS UAE

ENGIE Solutions is firmly rooted in the region, delivering the right infrastructure management and energy optimisation solutions to our customers right here in UAE.

Our global presence combined with local expertise enable us to provide customers with the right, locally-relevant solutions that yield real business results.



In B2B solutions (49%)  
Worldwide



40,000+  
employees



26  
Countries  
coverage



€28 Billion  
of worldwide  
revenue



24.4 million  
of individual client  
contracts worldwide



1800  
employees



30  
nationalities



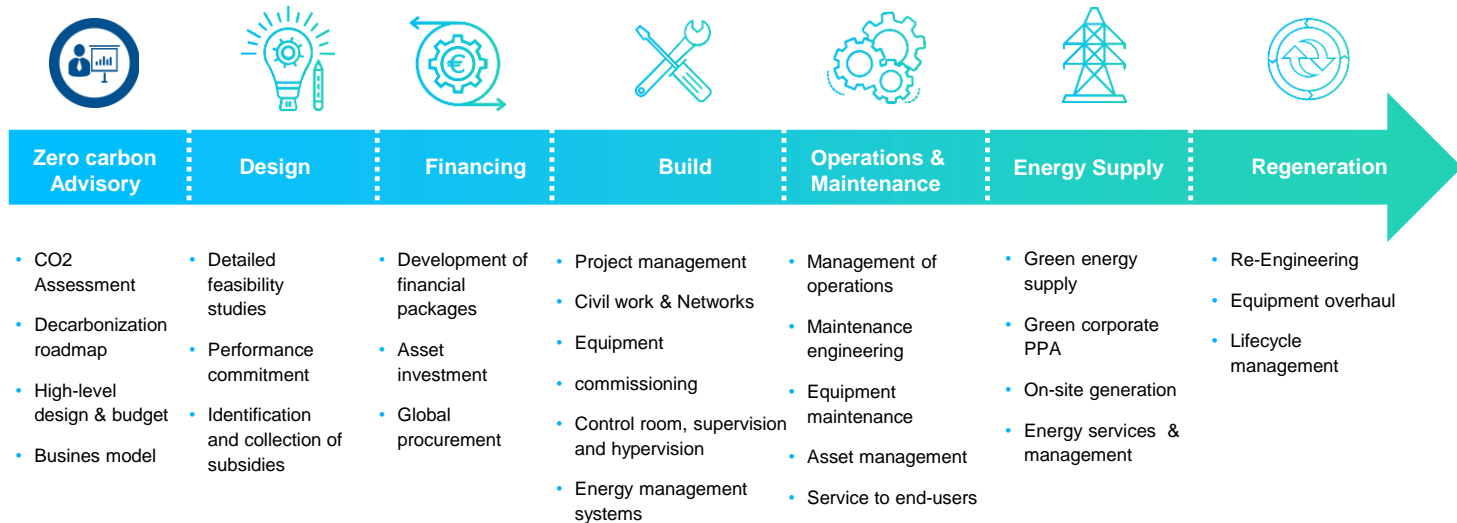
78  
Projects



11  
Million  
LTI free  
worked  
hours

# SOLUTIONS AT EVERY STEP OF THE VALUE CHAIN

Involved with every Project Phase ensuring Life-Cycle targets are achieved



# ENERGY SOLUTIONS : OUR PURPOSE

## ENGIE's Leadership



### Energy Efficiency

We are **the #1** energy efficiency service provider worldwide

We have + **5,000** energy efficiency contracts



### Energy production

ENGIE produces over **10,5 TWh of heat and cold & 1 TWh of electricity**



### Green Thermal

Our total installed **biogas and biomass capacity is ~8.3 GW**, with a growing position in Green H2



### Energy Systems

We have over **15,000** energy systems operated under **energy efficiency performance contract (EEPC)**

# CARBON NEUTRAL TRANSITION FOR INDUSTRIAL SECTOR

## Leveraging on Energy Efficiency & Onsite Utilities



# INCREASE ENERGY EFFICIENCY



## Integrated and tailor-made solutions

### YOUR NEEDS

- **Reduce consumption** of energy, water, refrigerants,...
- **Reduce operating and maintenance costs** by best practices and monitoring
- **Reduce energy waste** by heat recovery system

### OUR SOLUTIONS

- **Best available technology from design to implementation** for boilers, chillers, compressed air, energy management system, processes...
- **Heat recovery integration** in process & utility ; heat pumps, heat exchange,...
- **Expertise, business model including** financing & energy performance guarantee



# SHIFT TO GREEN ONSITE UTILITIES



## Integrated and tailor-made solutions

### YOUR NEEDS

- **Consume renewable electricity** RECs, green corporate PPA,...
- **Produce renewable electricity on site** PV, Wind, biomass CHP,...
- **Optimize your green electricity sourcing** contract duration, fix & indexed prices, balancing, risk management,...

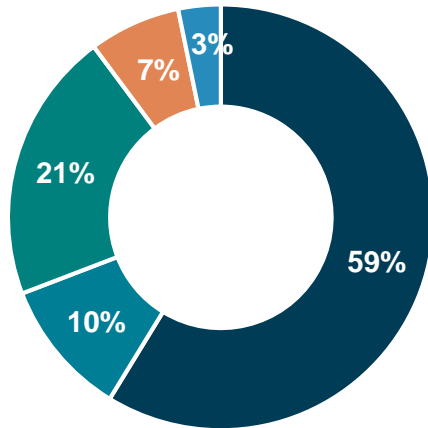
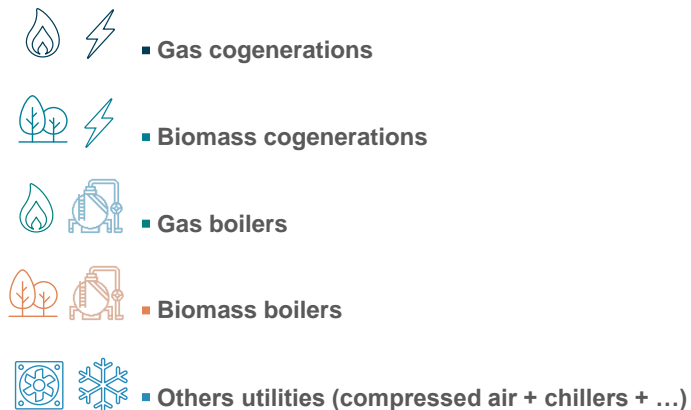
### OUR SOLUTIONS

- **Global portfolio of large renewable assets** PV & Wind farms, biomass & biogas power plants,....
- **Decentralized energy production capabilities** on site PV on rooftop & carport, on site biomass & biogas CHP
- **Advisory, sourcing & energy management services** Physical or virtual PPA, additionality, blockchain tracking pour green power



# ON-SITE UTILITIES – MAIN TECHNOLOGIES & FUELS (ENGIE)

BY TOTAL POWER (3,7 GW)



# WHERE HAS ENGIE HELPED SWITCH TO GREEN ONSITE UTILITIES?



Biomass - Saipol



Biomass CHP



Mars Chocolate  
Hagenau



Waste heat to steam



GreenPAC -CFR



Heat recovery & heat  
pump



Glass to beer  
industrial  
symbiosis



Heat recovery fumes to  
steam



Green H2 YARA new  
plant



Green H2 production



TRIBALLAT Avignon FR



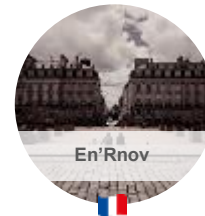
Steam from biomass



CPCU Paris



Heating network



En'Rnov



Heating network



# 8 WOOD-FIRED CHP PLANTS IN FRANCE (ON 5 INDUSTRIAL SITES + 3 DHCS)



# DECARBONIZED UTILITIES PRODUCTION THROUGH BIOMASS COGENERATION

## Vielle-Saint-Girons - FRANCE



### Zero Carbon Transition

- Green energy: Biomass boiler producing decarbonized heat combined with a steam turbine to generate power.
- Cost reduction on electricity supply by 16% and on steam supply by 13%
- 400,000 tons of CO2 emission avoided on the project lifetime
- Biomass must be supplied within 100 km radius of the facility of which 60% must come from Landes region, regulated by a French agency

### Technical solutions

- **20-year contract duration**
- Installed capacity: 50 MWth biomass boiler & 17 MWe steam turbine
- Production of steam (184 GWh/year) to DRT and production of electricity (90 GWh/year) sold to EDF
- A subsidiary of DRT provides the biomass, mainly wood wastes (150.000 t/year)
- The facility belongs to Biomass Energy Solutions Vielle Saint Girons : 51% owned by ENGIE, 37% by DRT and 12% by the Caisse des Dépôts et Consignation

# DECARBONIZED UTILITIES PRODUCTION THROUGH BIOMASS COGENERATION

## UAE Cement Factory



*First BOOT Waste Heat Recovery Project with ORC Technology for ENGIE Solutions in Middle East*

### Technical solutions

- Location : United Arab Emirates
- Contract Type : Design Build Own Operate Maintain & Transfer
- Sector : Industrial
- Contract Value : 25.6M USD
- Contract Period : 10 years
- Project Completion : Q4 2023
- Annual generation : 64.7 GWh
- CO2 Emission Reduction : 30.4k Ton/ Annum
- Top Solutions Proposed : Design, finance, and install Waste Heat Recovery system of 8,76 MW NET Avg that will capture the process heat and convert it to electricity for the plant.

# STEAM PRODUCTION FROM BIOMASS

## Chateaubourg - FRANCE



### Zero Carbon Transition

- Green steam: Biomass covers 80% of steam needs
- Local and renewable energy: biomass comes from forests and sawmills
- Circular economy: ashes are valued by composting

### Technical solutions

- **10-year steam supply contract**
- Installed capacity: 4.2 MW
- Annual production: 5 tonnes per hour
- Biomass: 6,000 tonnes per year
- ENGIE Solutions Financing : 3,8 m€ (0.8 subsidized)
- Operating savings : 22% (excluding financing rent)



# GREEN H2 SUPPLY

Grenoble (38) – France - 2016



## The site :

CEA Minatech

2 distinct uses of hydrogen:

- **Mobility**
- **Search: H2 ultra-purified 4.5 and 6.0**



## Une solution As a Service

- The global H2 supply solution funded by ENGIE :
- Sale of H2 with the expected specifications to the industrialist
- Guarantee of quality and availability of H2 supply
- Investment of the entire production plant

## Technical solutions

- **Commissioned in 2016**
- **First hydrogen production unit with solid storage in France**
- **Construction, operation and financing by ENGIE Solutions**
  - 3 electrolyzer 10 Nm<sup>3</sup>/h
  - Supplier McPhy

# MULTI-UTILITY PLATFORM

Villers Saint Paul - France – 2006 à 2021



## Customers:

Major industries on the site :

- ARKEMA,
- DOW CHEMICALS et
- CHEMOURS
- as well as a dozen small industries.

Individual contract between each industrialist and ENGIE Solutions

## Utilities As a Services

Single interlocutor with the manufacturers of the platform for all the services carried out on the site :

- Ensuring quality of service to partners meeting the requirements of a SEVESO II site, high threshold.
- Investing on behalf of industrialists in new steam production and effluent treatment facilities.
  - -5% energy consumption on steam
- Meeting all requirements pressure, temperature,...) for the utilities provided.
- Allowing facilities to be available

## Technical solutions

Production and distribution of utilities :

- Steam
- Gas
- compressed air,
- Nitrogen
- depleted air,
- demineralized water,
- filtered water,
- raw water,
- drinking water,
- treatment of effluents

Fourniture de services :

- Monitoring
- Safety
- welcome visitors,
- management of roads and various networks,
- green spaces,
- Phone

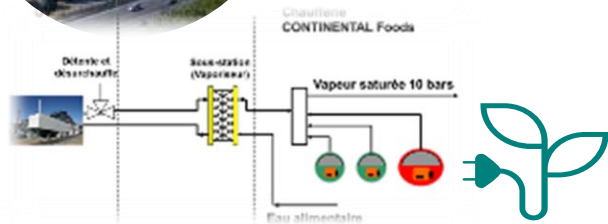
# STEAM SUPPLY

## Le pontet (84) – France - 2017



### The site :

- Soup production
- CONTINENTAL Food wanted to reduce the carbon footprint of its French site in order to remain competitive and green its assets



### Zero Carbon Transition As A Service

- The solution provides CONTINENTAL Foods with the 53,000 tonnes of steam used annually with a renewable energy coverage rate of more than 95%.
- ENGIE Solutions funds the 8 million euros of construction over the duration of the contract, conducts and operates the steam production facilities and provides steam with a commitment to quality (pressure, temperature and food properties), availability and coverage rate EnR,

### Technical solutions

- **15-year steam supply contract**
- A connection to the nearby SITA incineration plant to recover the fatal high temperature heat from the incineration process, to be transported on 2 km and processed as steam to CONTINENTAL Foods
  - The installation of a C13 cogeneration engine to ensure both the production of hot water needed for cleaning and some of the steam needed to properly operate the soup manufacturing process
  - Maintaining existing gas production to ensure 100% availability on steam

# TURNKEY PV CENTRAL SELF-CONSUMPTION

## Grenoble - France – 2017 - 2018



### Schneider Head quarters

Schneider Electric has affirmed its commitment to France with the ambitious Xpole project in Grenoble. This project is home to Schneider Electric's new innovation centre.



### Zero Carbon Transition

This campus, designed to combine quality of life, economic performance and scientific and academic dynamism, is a showcase for Schneider Electric.

- Reducing energy consumption through efficient buildings by promoting the use of renewable energy in self-consumption
- Reducing the carbon footprint

### Technical solutions

- A turnkey solution for self-consumption with photovoltaic installations in roofs and small wind turbines:
- Project development and design with the client
  - Design, procurement, installation of equipment
  - Controls
  - Commissioning
- 850kWc of solar power or 2484 panels
- 2 small wind turbines for a total of 6.4kWp
- Production of 990MWh



**Thank you**

