Fostering renewable energy integration in the industry

David de Jager
IEA-RETD Operating Agent

EPRI / IEA Workshop

Renewables and Clean Energy for Industries

Washington, 29/30 November 2016

IEA-RETD
Renewable Energy Technology Deployment

iea Energy Technology Network

Agenda

- RE-INDUSTRY Study Presentation
- Examples of case studies
- Preliminary policy recommendations

Context: The world of energy is changing

- The Paris Agreement asks for drastic GHG emission reductions to stay below the 2˚ Celsius temperature increase
- Industrial actors will have to play a significant role
- Integrating renewable energy (RE) generating assets in their sites, the industry can play an important role in the energy transition

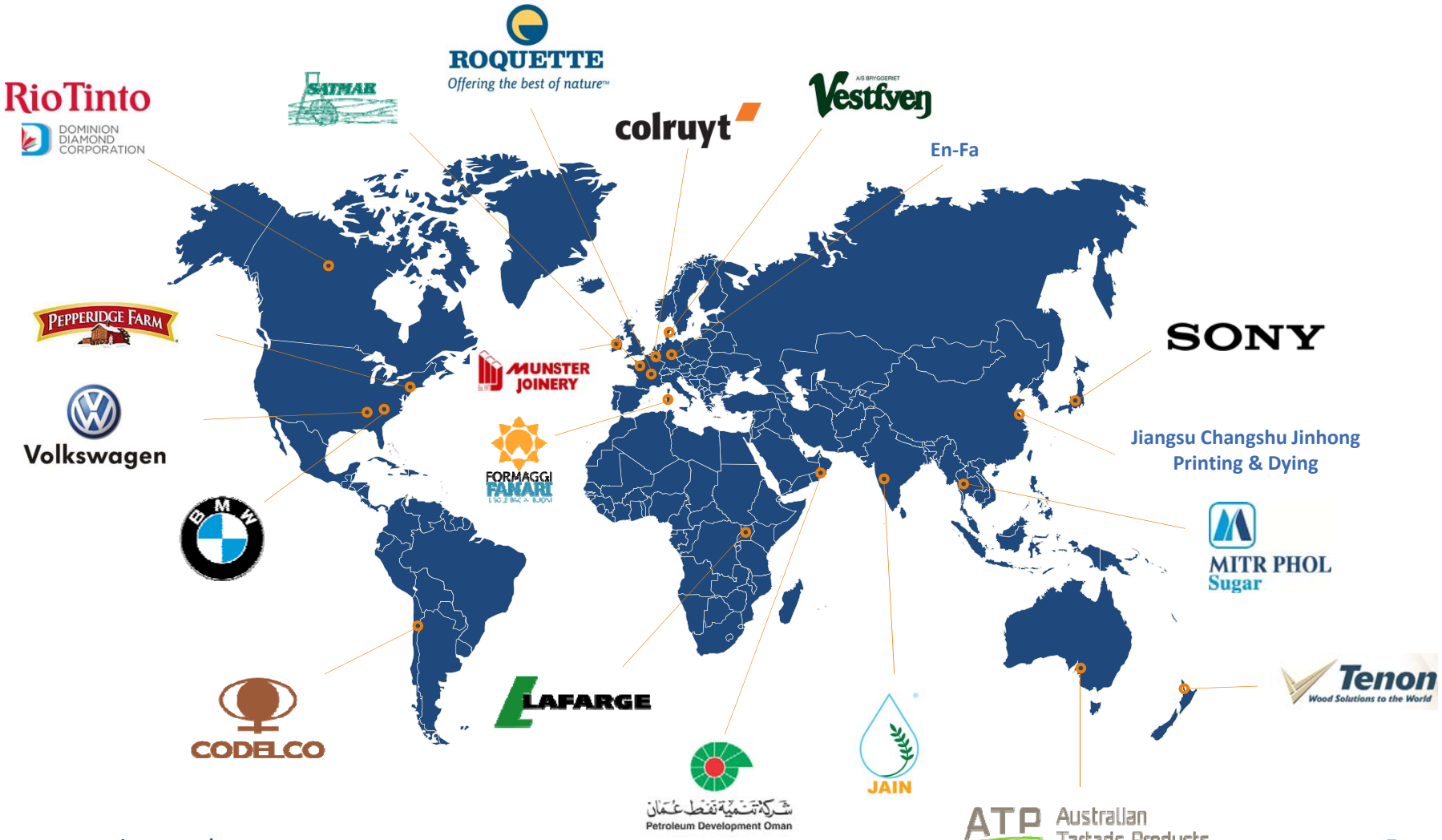
- Why should the industry deploy RE in their site:
  - Financial: Operational efficiency resilience
  - Security and adequacy of energy supply and price stability
  - Mitigation strategy with regards to regulatory risks (e.g. carbon price, or cap and trade)
  - Marketing strategy
  - International differentiation (reducing carbon footprint)

Objectives: Show-case RE in industry

- Provide inspiration and show-case state-of-the-art applications of RE in industry
- Present best practices and key developments of RE in the industry: existing and emerging technologies, challenges and opportunities, best practice policies and lessons learned by stakeholders
- Formulate policy recommendations to foster RE integration in the industry
- Design a communication plan to disseminate the study world-wide to policy makers and decision makers in the industry

- Project execution: Enea Consulting / Kerdos Energy
- Work in progress

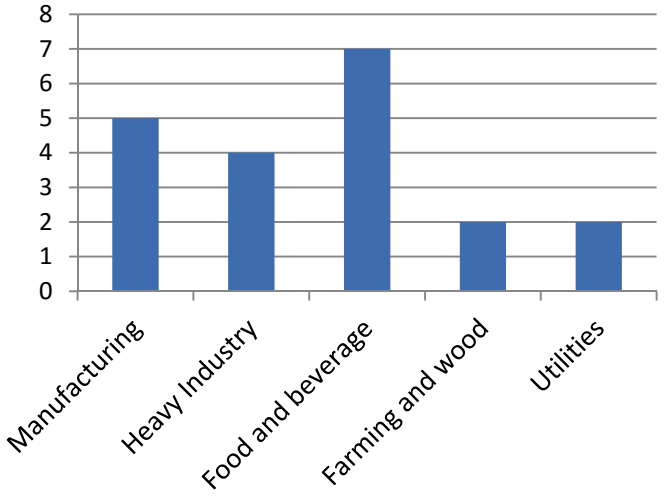
Presentation of the 20 selected case studies



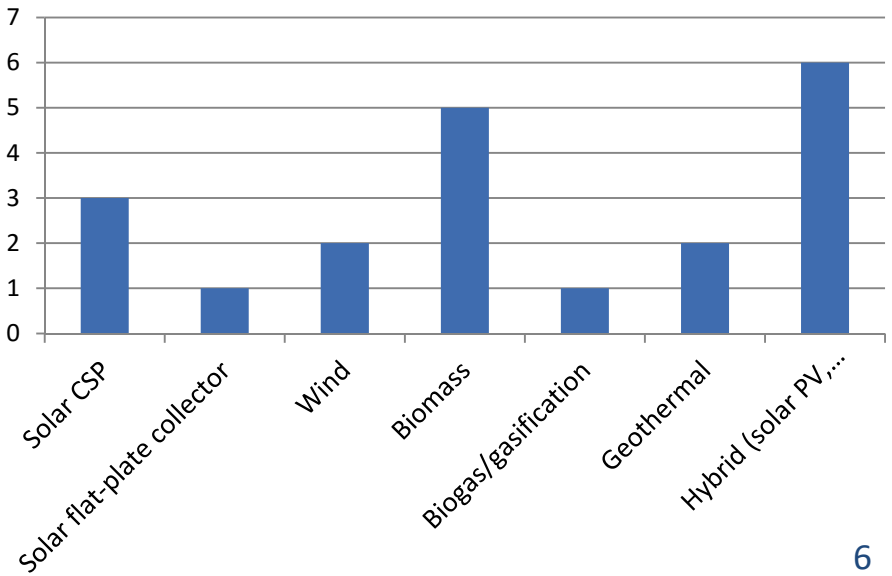
The 20 case studies were selected to represent most of the geographical areas, industrial sectors and RE technologies

Projects distribution by region

Projects distribution by industry



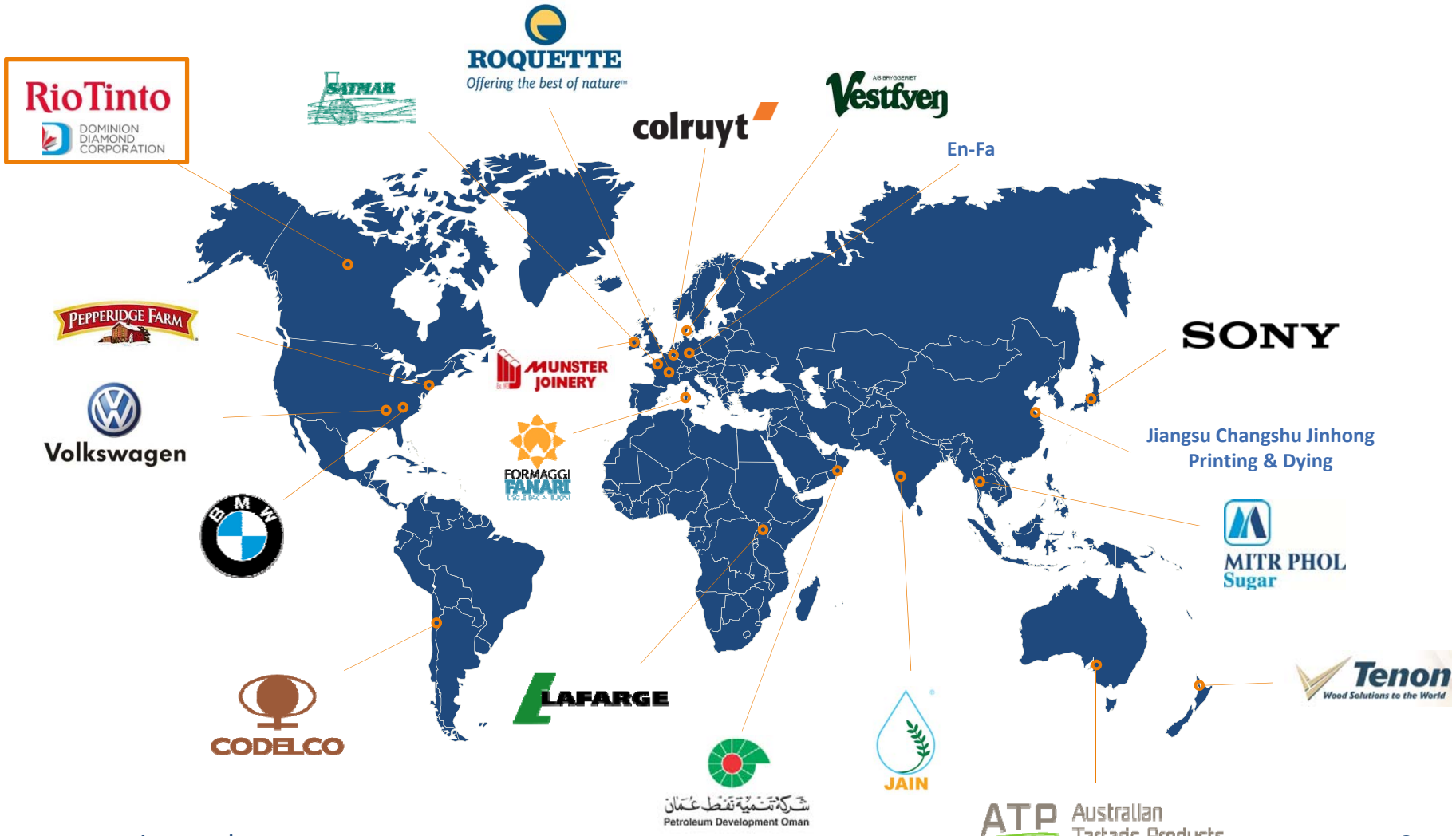
Projects distribution by type of renewable energy



Agenda

- RE-INDUSTRY Study Presentation
- Examples of case studies
- Preliminary policy recommendations

Case study 1: Rio Tinto / Diavik Diamond Mines – wind energy



Wind turbine for electricity generation in at a mining site

Company: Diavik Diamond Mines Inc
Industry: Heavy industry
Year: 2012

Courtesy of Diavik Diamon Mine

Technology

Wind turbine

Installed capacity

9.2 MW_e

CAPEX of the project

EUR 25.7 million
Fully funded by Diavik Diamond Mine

Benefits

Annual savings:
Approx. EUR 5.4 million

Annual fuel savings:
5,200 m^3 of diesel

GHG emissions reduction:
14,404 tons of CO_2 per year

Main political / regulatory drivers

- No political driver for the project

Replicability

- All industries
- World wide, minimum 4 – 6 m/s wind speed
- Particularly suitable for off-grid locations

Industrial sector: Mining

- Main sources of energy: electricity, diesel fuel, natural gas, gasoline
- Other sources of energy: Heat
- Energy often generated on site (remote locations)
- Requires stable energy supply

Example of Sub-Saharan African mines:

- Energy accounts for up to 25% of mine operating costs
- Demand for power mining operations expected to triple by 2020
- Power required to operate a medium size diamond mine: 3 MW
- Energy consumption: 30 GWh per ton

Project site

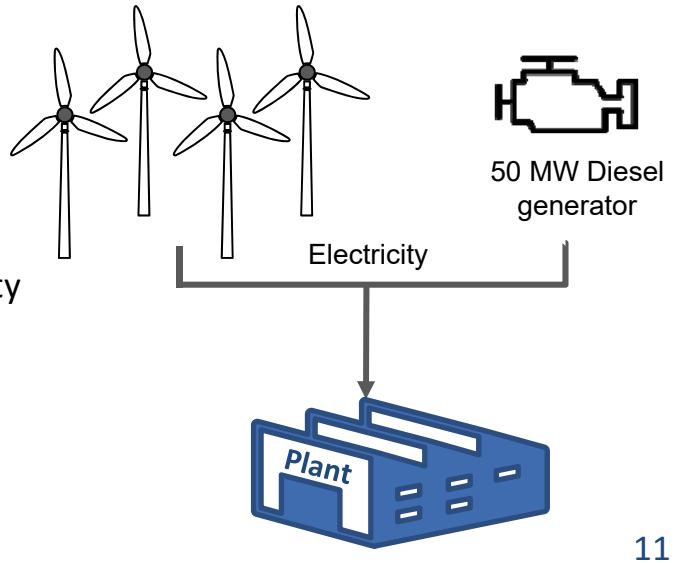
- **Local energy context (2014)**
  - Industry: 24% of Canada's Energy consumption
  - RE energies: 4,5% of electricity production
  - Wind power: 76% of RE electricity generated in Canada
- **Diavik Diamond Mine**
  - Nonmetallic mining company
  - Joint venture between Rio Tinto (60%) and Dominion Diamond Corp (40%)
  - EUR 56 million revenue
- **Site**
  - One of the world's preeminent sources of gem diamonds
  - Proven and probable reserves: 52,8 millions carats
  - 6-7 million carats per year (mostly large, white gem-quality diamonds)
  - 50 million liter/year of fuel required

Drivers for the project

- Prior 2012: 50 million liters of fuel required and transported over 353 km icy roads each winter -> $50 million/year cost
- Price and road transportation of fuel impacted by climate change (e.g. thin ice unfit for road transport)
- Sustainability goals: diversify energy sources, reduce reliance on diesel by 10%, lower mine's carbon footprint by 6%
- Demonstrate wind energy as a viable option for the Northwest territories and develop local expertise in the sector

Detailed technology description

- Four wind turbines, 2.3 MW each, manufactured by ENERCON
- Wind turbines owned and operated by Diavik Diamond Mines
- Wind turbines designed to operate in temperatures < -30˚C
- Minimum required wind speed for power generation 6.9 m/s
- Wind farm covers 11.2% (1.9 GWh per year) of mine electricity demand (17.3 GWh per year)



Project assessment – Technical and economic

Economics

- CAPEX: EUR 25.7 million

  Fully funded by Diavik Diamond Mine
- Payback period: 8 years
- Implementation complexity: Heaters in place for maintenance needs, lubricants adapted for cold weather. No existing wind mapping

Benefits

Annual savings: EUR 4 – 4.7 million

Annual fuel savings: 5,200 m^3 diesel

GHG emissions reduction : 14,404 tCO_2 per year

Other benefits: Annual winter haul reduced by 100 trucks per year

Pros/cons analysis

Advantages	Limits and shortcomings
• Possible to retrofit on existing assets • Low maintenance requirements despite extreme conditions • Fuel savings • GHG emissions reduction	• Higher initial investment • Long development and implementation complexity • Noise produced by rotor blades • Wind resources suitable for power production often located in remote regions, far from areas of electric power demand • Power capacity depending on wind speed

Case study 2: Roquette starch plant - bio/geothermal energy

Wood biomass boiler and deep geothermal steam plant at starch factory

Company: Société Roquette Frères
Industry: Food and beverage
Year: 2011/2016


Source: ADEME

Technology

Biomass
Deep geothermal

Installed capacity

- 43 MW_{th}, 60 tons steam/hour
- 24 MW_{th},

CAPEX of the project

- CAPEX: EUR 33 million
- CAPEX: EUR 44 million

Benefits

Confidential

Annual fuel savings
- 346 GWh
- 186 GWh

GHG emissions reduction
110,000 tCO2 per year

Main political / regulatory drivers

- ADEME “Fond chaleur”, grant: EUR 11 million (for biomass boiler)

Replicability

- Industrial sites with large heat demand
- Sustainable biomass source available (preferably locally)

Industrial sector: Food & Beverage

- Energy pattern of the sector:
  - Types of energy consumed: electricity, gas, heating and refrigeration
  - Energy consumption in food industries in France: Electricity (26%), gas (33%)
  - Food, beverage and tobacco industry accounts for 5% of global industry energy consumption
  - Share of energy cost in food & beverage industry in the world: 1 – 10%

Project site

- **Local energy context (2014)**
  - RE: 9,4% of energy consumption in France
  - 39% of RE production coming from wood biomass, 1% from geothermal
  - 75,8% wood and 1,8% geothermal intended for heat production
- **Société Roquette Frères**
  - One of the world leaders in starch processing
  - 30 sites throughout the world
  - Turnover: EUR 3,3 billion (2015)
  - More than 700 derivatives made from starch
- **Beinheim plant**
  - 2 starch plants (corn, wheat)
  - 1 ethanol plant
  - 1100 tons corn, 1200 tons wheat per day
  - Wood chips consumption: 150,000 tons per year
  - 60 tons steam per hour (biomass boiler)

Drivers for the project

- Reduce reliance on fossil energies and GHG emission
- Roquette Frères's objective: 75% renewable energy in 2015
- Increase profitability

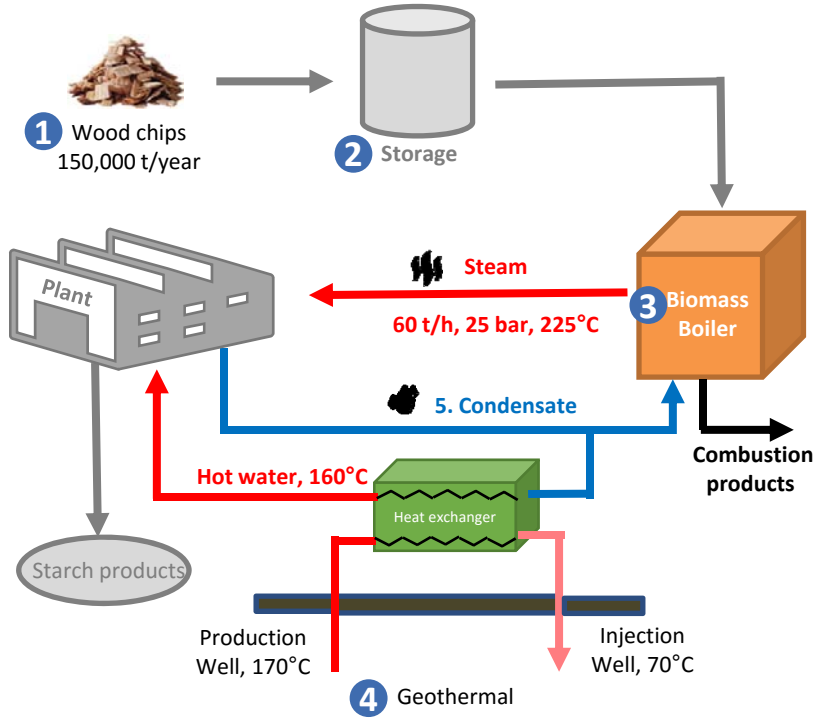
Detailed technology description

1. Wood chips: 60% from forestry exploitation, 40% from wastes of wood industry

2. Storage designed to regulate feedstock moisture

3. Biomass boiler (installed in 2011) produces steam used for wheat processing (a gas boiler is present as backup)

4. In addition to the biomass boiler, a geothermal plant located at 15 km from site was commissioned in 2016 to produce 170°C process hot water



Results

- CAPEX: EUR 44 million
- CAPEX: EUR 44 million
- Grant from ADEME: EUR 11 million
- Joint investment: Roquette Frères (40%), Groupe ES (40%), Groupe caisse des dépôt (20%)
- ROI: confidential

Benefits

Annual savings: N/A

Annual fuel savings[3,6]:
- 346 GWh natural gas
- 186 GWh

GHG emissions reduction[1]: 110, 000 tCO2/ y

Other benefits:

Local job creation

Pros/cons analysis

Advantages	Limits and shortcomings
Wood biomass: • Great way to utilize waste wood • Biomass waste is cheap & stable price • GHG emission reduction Geothermal: • Stable supply • Flexible operation	• High investment cost (Biomass & geothermal) • More space required than gas or oil boiler (Biomass & geothermal) • More space required to store fuel (Wood, straw, etc) • Variability of feedstock's moisture and calorific value (Biomass) • Geothermal: Very location specific (most resources are not cost-competitive).

Case study 3: Jain, India: tri-generation from biological waste

Tri-generation from bio-methanation at fruit and vegetable processing plant

Company: Jain Irrigation Systems Ltd.
Industry: Food and beverage
Year: 2010

Technologies

Bio-methanation plant
Combined Heat and Power
Heat recovery absorption chiller

Installed capacity

1.67 MW_e

1,200 kg/h steam

CAPEX of the project

EUR 5.765 million

Benefits

Annual savings: EUR 578,000

Annual electricity savings: 10 GWh

GHG emissions reduction 6,690 tCO_2 (CDM)

Main political / regulatory drivers

- UNFCCC's Clean Development Mechanism (CDM)
- Indian MNRE's Renewable Energy Certificate

Replicability

- Food and beverage industry
- Agriculture
- Secured organic waste supply chain available

Industrial sector: Food and Beverage

- Main sources of energy: electricity, diesel, natural gas, biomass, biogas
- Other energies: Low-temp heat, refrigeration, including sub-freezing
- Need for stable power supply to ensure constant food refrigeration
- Accounts for 6 % of India's energy consumption in industry (2007)[5]
- Activity may depend on harvesting seasons

Company and project site

- **Local energy context**
  - RE: 17 % of India's energy mix
  - Average power outage time in Maharashtra (2014): 3 hours per month
- **Jain Irrigation Systems Ltd**
  - Large multinational
  - Turnover: over EUR 800 million
  - Various activities: irrigation systems, piping, food and beverage, solar panel manufacturing
- **Jalgaon Plant**
  - Fruit and vegetable processing plant
  - 600 to 1,100 tons per day
  - Production lines and 27 refrigerated storage rooms
  - One solar panel manufacturing unit
  - Electricity supplied by the North-East-West-North East (NEWNE) grid

Drivers for the project

- Yield-to-waste ratio of 50:50: waste-to-energy instead of expensive waste treatment
- Sustainability-oriented company: Company's motto is "Leave this World better than you found it".
- Positive corporate image and energy cost savings

Detailed technology description

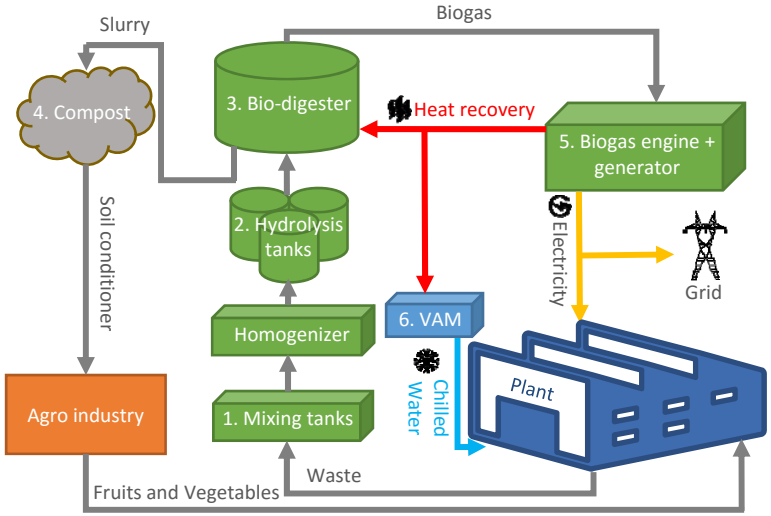
1. Organic waste crushed, mixed and homogenized: 200 tons/day

2 & 3. First and second stages of aerobic and anaerobic digestion

4. Slurry sent to compost to produce marketable soil conditioner

5. Electricity produced by 2 x 834 kW biogas engines. Combination of self-consumption and grid feed-in-tariff

6. Chilled water, produced by a Vapor Absorption Machine (VAM) supplied by steam produced from engine heat recovery, is used in cold storage rooms and solar panels manufacturing units



Wind power and biomass CHP at a window and door manufacturing plant

Company: Munster Joinery
Industry: Manufacturing
Years: 2008 and 2009

Technology

On-site wind
Wood biomass CHP

Installed capacity

Wind: 4 MW_e
CHP: 3 MW_e
CHP: 12 MW_{th}

CAPEX of the project

Wind: EUR 6.1 million
CHP: EUR 10 million

Benefits

Savings:
EUR 200,000 / year (Wind)

Annual fuel savings
30% of total plant's requirement (Wind)

GHG emissions reduction
31,250 tCO_2/year

Main political / regulatory drivers

- SEAI EUR 1 million grant
- Gate 2 Group Scheme: grid connection agreement
- EU 25 % RE generation goal 2020 Directive

Replicability

- Wind: worldwide, minimum 4-6 m/s wind
- CHP: Industries with low/medium temperature heat demand and available biomass supply

Drivers for the project

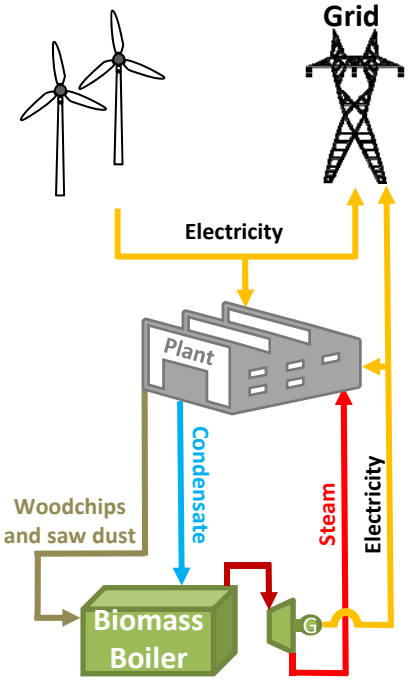
- Quote from Sean Michael, Finance Manager at Munster joinery: **"Changes in the electricity market in Ireland were imposing increases of 20% – 25% on our energy bills. The installation of these turbines gives us the opportunity to break the link with energy inflation, to reduce our carbon emissions and is consistent with our product marketing messages."**

Detailed technology description

Wind Turbines

- Wind Energy Direct (WED) installed, operates and maintains two 2 MW wind turbines on Munster Joinery's (MJ) plant ground
- Power generated by the turbines is sold by WED to MJ to run their plant. Wind power accounts for 30 % of the plant's total energy consumption
- Any additional power is sold to ESB Networks grid authority

Project by Wind Energy Direct Ltd. 3 years from planning to commissioning



Biomass CHP

- 12 MW steam boiler is fed with woodchips and sawdust, byproducts of the plant's processes
- The boiler produces 15 tons/hr of steam at 400˚C and 25 bar
- Steam expands through a 3-stage, 3 MW turbine to provide power to the plant. Any additional power is sold to ESB Networks grid authority
- Residual low-pressure steam is used in the kilns, paint machines and space heaters.

Project by Fingleton White & Co. 3 years from planning to commissioning

Agenda

- RE-INDUSTRY Study Presentation
- Examples of case studies
- Preliminary policy recommendations

Create the conditions for the exchange of information and cooperation between stakeholders

- Map existing national RE potential in industry by type of energy, technology solution and industrial sector
- Develop dialogue at both local and national scale levels between state administrations, RE and industrials sector unions, network operators, regulatory agencies, etc.
- Financial support and regulatory framework can be designed based on both:
  - Top-down communication from public agencies on existing regulatory and financial tools
  - Bottom-up communication from industrial and RE actors in order to rank best available "plug-and-play" solutions and to analyze barriers
  - Special attention to process integrated solutions, notably heat

The international cooperation regarding energy efficiency (for example, waste-heat-to-power technologies implemented in cement factories) can be used as an example of such successful multi-stakeholders initiatives

Support the development of a resilient and competitive deployment of renewable energies in the industry

- Subsidize feasibility studies in industrial sectors with the strongest potential

- Set up fiscal incentives and subsidies reducing the payback time for industries and increasing access/availability of capital
  - Subsidize investment costs through calls for proposals (energy specific and/or performance criteria funds)
  - Enable net metering schemes for electricity consumed onsite

- Finance pilot projects for non-mature technologies with significant growth potential (hybrid projects, combined electric thermal energies, etc.)

Redirecting existing (indirect/implicit) fossil fuel subsidies for industry to RE support incentives can provide additional financial capacities

Adapt existing regulatory framework to the requirements of industry in order to facilitate access to private capital

- Authorize 3rd party players to invest and/or produce electricity that can be directly sold to industries, such as an Independent Power Producer (IPP), enabling new business models for on-site RE integration projects
- Develop a stable, predictable regulatory framework addressing specific operational issues such as re-selling conditions or dismantling
- Create streamlined regulatory requirements and simplified authorization procedures for renewable energy projects within industrial sites
- Improve progressively the existing regulatory framework through local experiments; such as self consumption, energy carriers and products exchanges (e.g. biomass), and decentralized storage within industrial eco-systems

The European Directive 2009/72/CE authorizes member states not to apply DSO unbundling requirements for "*integrated electricity undertakings serving less than 100,000 connected customers, or serving small isolated systems*" (Art. 26)

IEA-RETD

Define medium- and long-term targets in order to bring together actors towards a common objective

- Defining specific targets within national renewable energy roadmaps would provide a clear, long-term view to the sector, facilitating long term investments and new initiatives

- Deploying RE in the industry can also be a path for countries around the world towards achieving their climate change commitments under the Paris Agreement

- The private sector may be involved in reaching these goals through cross-sectorial initiatives (for example RE100), going beyond individual actions

- (Some industry sectors can play an important role in the energy transition by offering flexible demand: this may be an important enabler for large-scale deployment of RE)

THANK YOU!

For additional information on RETD

Online: www.iea-retd.org
Contact: info@iea-retd.org

IEA-RETD

Renewable Energy
Technology Deployment

iea Energy Technology Network