



# FICHTNER

## Company Presentation of the Fichtner Group

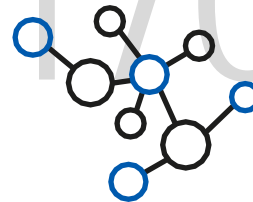
Energy Efficiency in Industry

7 May 2019

Manila



Established in 1922 and  
family-owned ever since



Project experience in  
more than 170 countries



Total turnover of  
€246 million in 2017



More than 1500 employees  
worldwide – over 500 of  
these in our home office



Long-standing employees  
from 66 nations



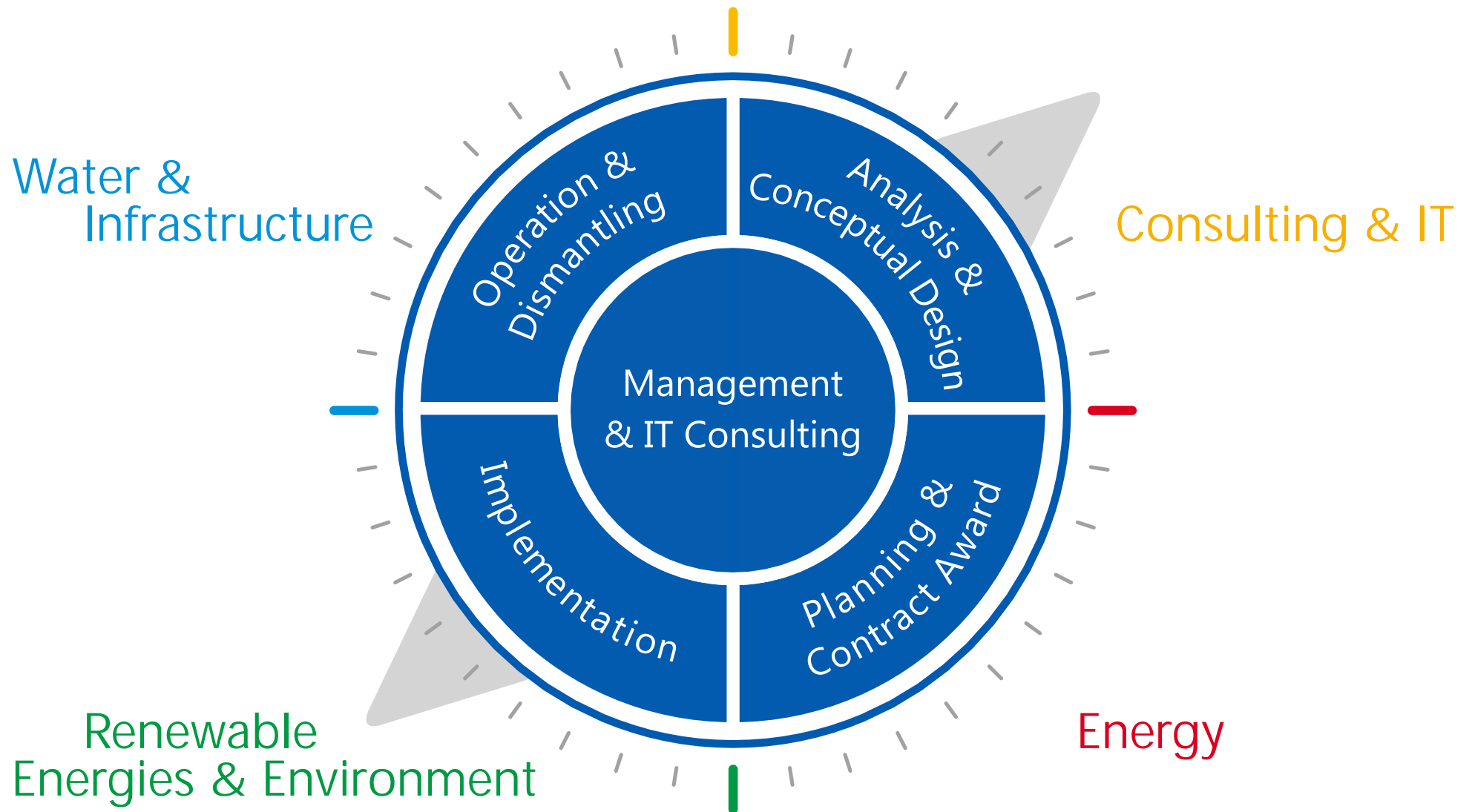
Certified systems for quality,  
workplace health, safety, compli-  
ance, environmental protection

22 companies

60 countries

100+ locations

Home office in Stuttgart | 22 subsidiaries and affiliates  
Over 100 branch and project offices | Present in 60 countries worldwide



Planning and consulting in all project phases -  
for technically and economically sound solutions



Fichtner –  
Shaping  
the future  
together

## INDEPENDENT

We are an owner-managed family business that has maintained its independence in order to seek objective and customer-oriented solutions.

## COMPETENT

Highly qualified employees, decades of experience and a comprehensive quality management ensure project success.

## INTERNATIONAL

Thanks to the global nature of the Fichtner group with its worldwide network, projects can be handled close to the customer.





# Energy

With technical and economic expertise, we advise on all current issues, from energy procurement to its efficient use.

- Energy economics
- Conventional power plants
- Power transmission and distribution
- Automation and telecommunications engineering
- E-Mobility
- Energy transportation and storage
- Energy Management
- Oil & Gas



## Renewable Energies & Environment

With highly qualified engineers and consultants, we work on complex projects in the field of renewable energies and the environment.

- Renewable energies
- Environmental studies
- Permit engineering
- Environmental management
- Environmental protection technologies
- Waste management





## Water & Infrastructure

With technical, ecological and economic know-how, we advise on the construction and operation of infrastructure facilities and ensure the responsible use of water resources.

- Integrated water resources management
- Water supply and sanitation
- Seawater desalination
- Architecture and building construction
- Civil engineering and structural planning
- Transportation
- Mining and minerals
- Geotechnics



## Consulting & IT

With comprehensive consulting services and a high degree of IT expertise, we complement the engineering services in all our business areas.

- Strategy and organization consultancy
- Transaction advisory services
- Economic consultancy
- Project management
- Arbitration proceedings
- Asset management
- IT consultancy
- Smart IT solutions
- Smart energies



# Energy Efficiency (EE)

## Range of services

Fichtner is supporting clients all over the world in using their energy more efficiently and thereby saving costs and emitting less green house gases. Areas to improve energy efficiency are within conversion of energy such as generation of power or heat and the end-use of energy such as within industrial production, buildings or Small and Medium Enterprises (SME). Our services comprise:

- EE audits and specification/design of EE measures
- Implementation of Energy Management Systems (EnMS) and Energy Monitoring Systems (EMS)
- Design and execution of trainings on: EE audits, EE marketing, EnMS and EMS (e.g. Train-the-Trainer)

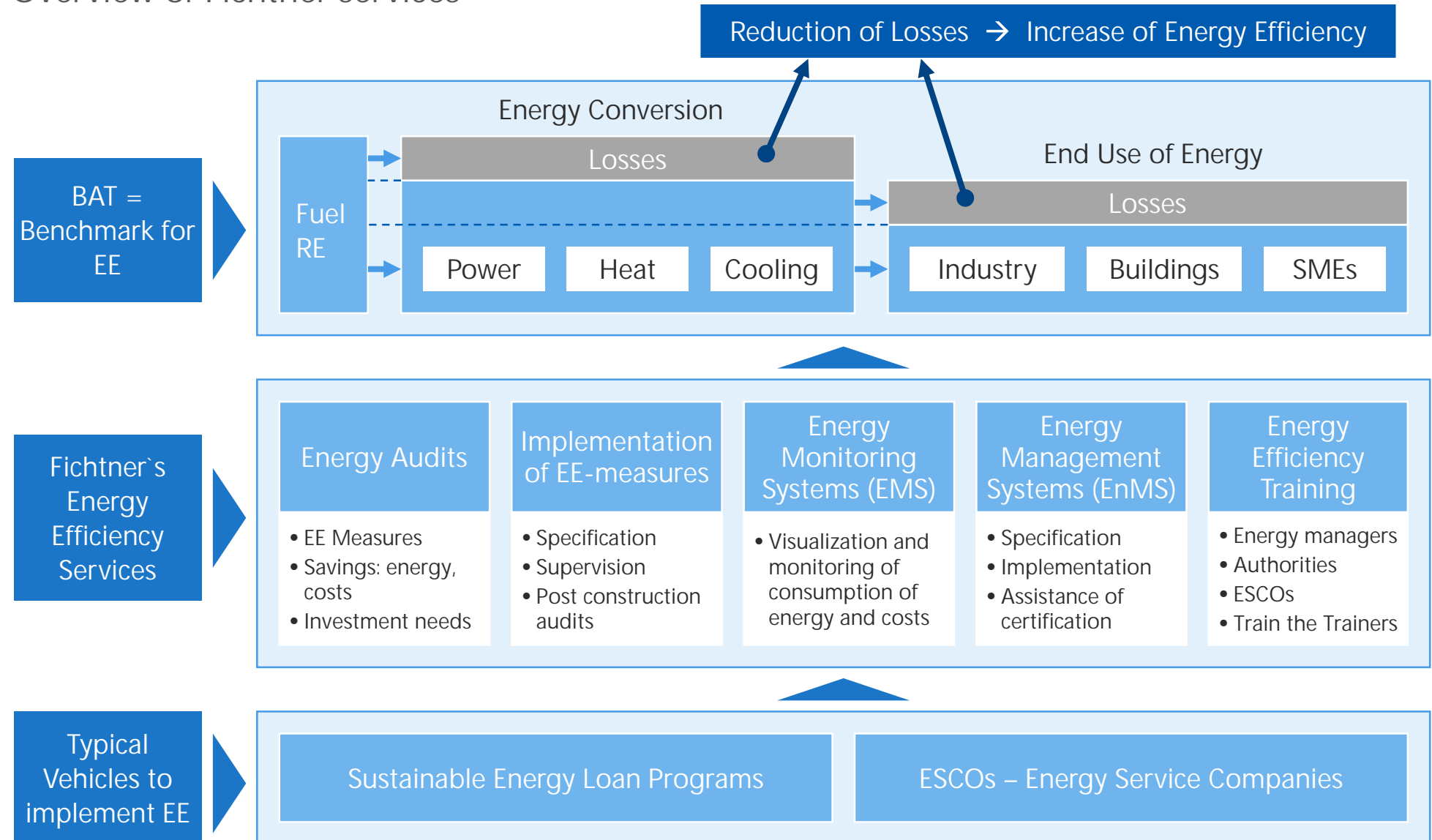
On behalf of Development Banks Fichtner is operating Sustainable Energy Loan Programs:

- Marketing of EE financing opportunities
- Collection and assessment of EE project proposals
- Development of energy audits
- Assessment and monitoring of EE improvements



# Energy Efficiency (EE)

## Overview of Fichtner services





# Energy Efficiency (EE)

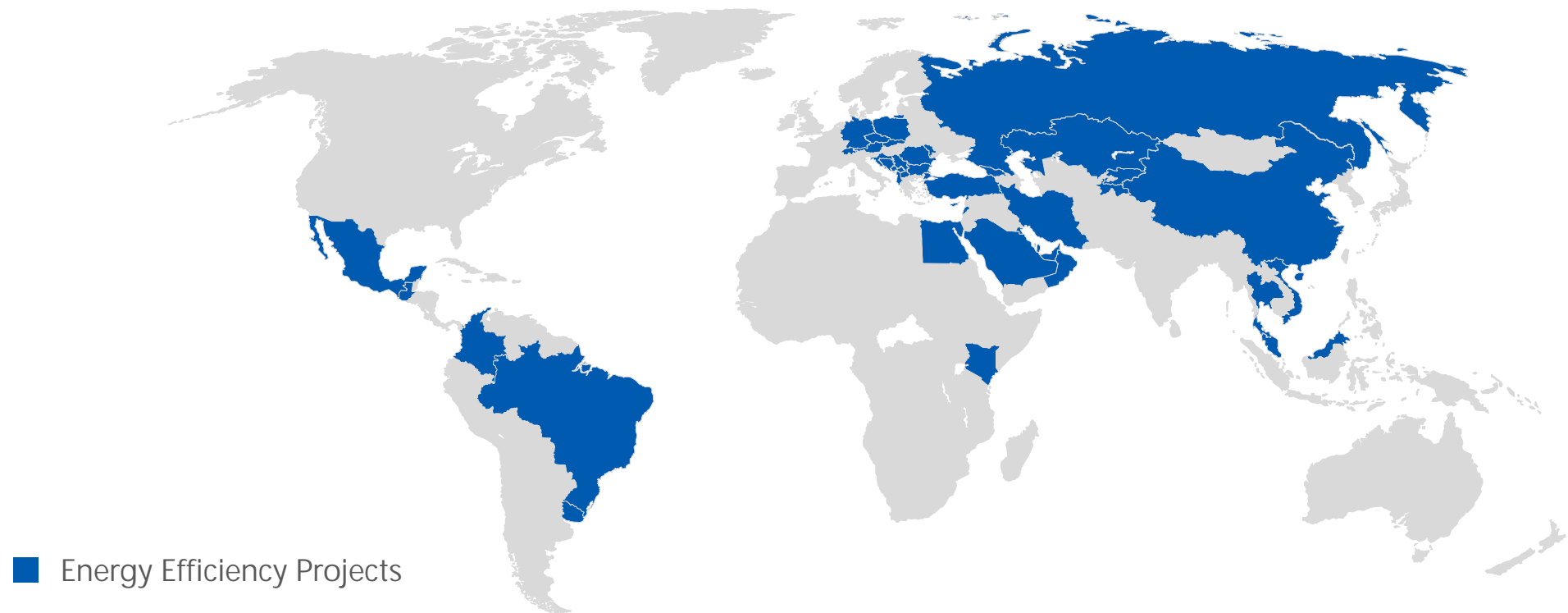
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## Experience - Overview



Fichtner has a broad international experience in the field of energy efficiency, such as:

- Handling more than 300 EE projects in industry, SMEs, municipalities and buildings
- Working on EE projects in more than 40 countries worldwide
- Operating 12 Sustainable Energy Loan Programs



# Energy Efficiency (EE)

## Selected References



1	Energy Efficiency and Resource Audits in the industry in Middle and South America	 04/2010 – 11/2013	 6 industrial energy audits
2	Moldovan Sustainable Energy Financing Facility (MoSEFF) for Small and Medium Enterprises	 09/2009 – 12/2017	 577 EE applications, 271 EE audits
3	Energy audits and of energy efficiency measures in public buildings in Montenegro	 01/2012 – 12/2015	 40 EE audits, 30 EE projects implemented
4	Energy management system, energy monitoring system, building inventory; Montenegro	 10/2017 – 11/2021	 Energy Management & Monitoring tools

# Energy Efficiency

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## Energy efficiency and resource audits in the industry in Middle and South America

DEG is seeking financing opportunities and intends to finance measures for raising energy efficiency and conserving resources in industrial plants. To justify the financing decision Fichtner undertakes energy and resource audits.

### Fichtner services:

- Site visits to review production processes and assess energy and resource efficiency
- Energy audits to review the suggested and identify further measures for upgrading energy efficiency and using renewable energies
- Audited plants:
  - Guatemala: sanitary paper factory; sugar factory
  - Brazil: wood processing facility
  - Uruguay: plywood and fiberboard factory
  - Mexico: sugar refinery; wood processing facility





# Energy Efficiency

## Moldovan Sustainable Energy Financing Facility (MoSEFF) for Small and Medium Enterprises

EBRD has established the Moldovan Sustainable Energy Financing Facility (MoSEFF) with the aim of financing energy efficiency (EE) and renewable energy (RE) projects in Small and Medium Enterprises (SMEs). Another aim was to familiarize local banks with appraising and financing EE and RE projects. As an anticipated outcome a self-financing market for investments in sustainable energy projects is established in Moldova. Fichtner acted as project consultant for managing and implementing the MoSEFF.

### Fichtner services:

- Marketing campaigns to promote the financing facility
- Working with local banks in developing a project pipeline
- Assessment of 577 EE and RE project applications
- Site visits and identification of further opportunities to improve EE and use RE
- Energy Audits and approval of 271 EE and RE projects
- 104 public seminars, 24 workshops with local banks
- Monitoring and reporting of facility performance to EBRD



European Bank for Reconstruction and Development (EBRD), London



09/2009 – 12/2017



577 EE applications,  
271 EE audits

# Energy Efficiency

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## Energy audits and energy efficiency measures in public buildings in Montenegro

The Government of Montenegro has launched the “Energy Efficiency Program in Public Buildings I” (EEPPB I). The Ministry of Economy has taken the lead in implementing all energy efficiency projects under the Energy Efficiency Law. Fichtner acts as the Program Consultant to provide consultancy services to execute the EEPPB I.

### Fichtner services:

- Assessment of 40 educational buildings by walkthrough audits and preparation of a shortlist of 30 eligible projects
- Conduction of 30 detailed energy audits
- Preparation of conceptual and final design
- Preparation of tender documents and guiding tender process
- Supervision of construction works
- Post-construction energy audits to confirm the target of 20% energy savings
- Support to set-up an energy efficiency training program



Ministry of Economy, Sector for Energy  
Efficiency, Podgorica



01/2012 – 12/2015



40 EE audits, 30 EE  
projects implemented

# Energy Efficiency

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## Energy management system, energy monitoring system, building inventory; Montenegro

Fichtner supports the Government of Montenegro in the implementation of the "Energy Efficiency Program in Public Buildings II" (EEPPB II) funded by KfW. The program supports the implementation of the "European Public Building Directive" and provides the basis for the future issuing of "Energy Performance Certificates" for buildings. The activities of the project are related to all 5000 public buildings in Montenegro.

### Fichtner services:

- Energy management system: concept development
- Energy monitoring system: concept development, support within tendering, bidder selection, supervision of implementation
- "Energy Performance Certificate" software: supervision of development
- Implementation of a building stock inventory, collection of structural building data
- Energy efficiency classification of buildings and definition of reference buildings
- "Cost optimal level" – analysis of reference buildings
- Support of the update of the national energy efficiency rules
- 59 Post construction audits of buildings refurbished in EEPPB I



Ministry of Economy, Sector for Energy  
Efficiency, Podgorica



10/2017 – 11/2021



Energy Management  
System, Energy Monitoring  
System, Building Inventory



# Energy Efficiency

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Training on energy efficiency and environmental compliance; Georgia, Montenegro, Republic of Moldavia, Romania, Serbia

In countries where EBRD is active, Small and Medium Enterprises report on low energy performance compared to international average. Reasons are obsolete technologies, lack of information on and awareness of energy efficient technologies, difficulty in accessing financing, no or a limited number of consultants being able to deliver Energy Efficiency (EE) services. The objective of the assignment is to design and deliver EE trainings to local consultants.

## Fichtner services:

- Undertake local training needs assessments
- Prepare curriculum and training material for industrial and building EE courses for different knowledge levels
- Carry out training courses in different countries including presentations, exercises and on site audit demonstrations
- Train on how to sell energy efficiency consultancy services
- Provide a set of tools to assess EE measures
- Provide follow-up mentoring to local consultants



European Bank for Reconstruction and Development (EBRD), London

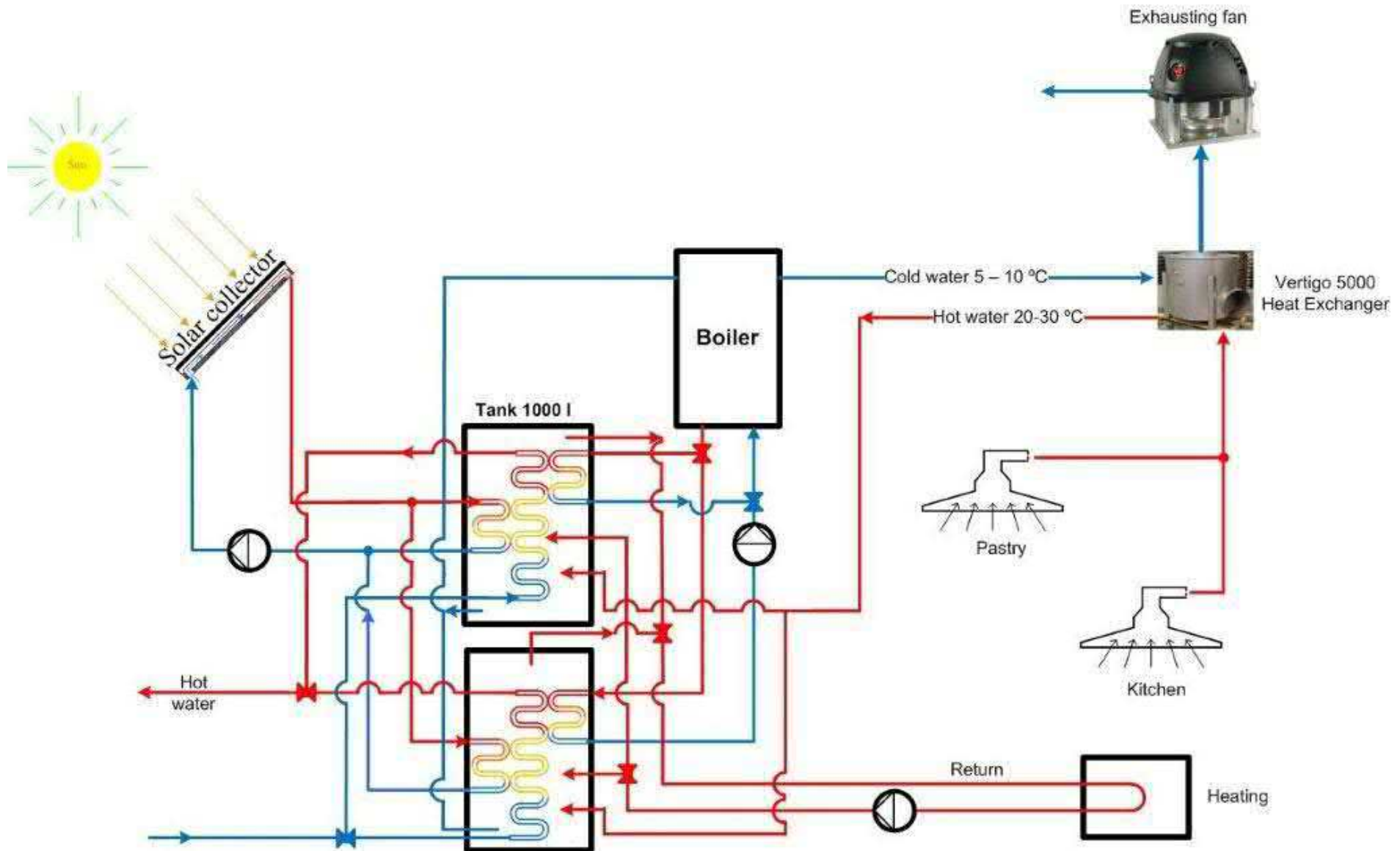


03/2013 – 11/2014



4 different EE training courses of 3-5 days

## Posta Veche, solar system



"Hotel Dacia" in Ungheni was built in 1976 and has been out of order for the recent 8 years. The hotel is planned to be reopened in spring 2011 and will complete with all rehabilitation works in autumn 2011. The hotel will contain 3 conference rooms and 58 guest rooms; 30 of them with two single beds and 28 rooms with one big (double) bed. This leads to a total of 116 guests who could stay overnight as the maximum. With the aim to improve energy efficiency in the hotel, the company decided to enter the MoSEFF program. Due to this "Hotel Dacia" reached energy savings in an amount of 80% that greatly improved the company's economical situation.



<b>Region</b>	Ungheni, Moldova
<b>Energy Consumption</b>	830 MWh per year
<b>Project Goals</b>	<ul style="list-style-type: none"> <li>➤ Installation of solar collectors</li> <li>➤ Thermal insulation and replacement of windows</li> <li>➤ Gas grid connection</li> <li>➤ Installation of condensing boilers and rehabilitation of heat distribution system</li> </ul>
<b>Main Investments</b>	<ul style="list-style-type: none"> <li>➤ Solar collectors</li> <li>➤ Insulation of building shell</li> <li>➤ Windows replacement</li> <li>➤ Gas grid connection</li> <li>➤ Condensing boilers</li> <li>➤ Heating distribution system</li> </ul>
<b>Investment volume</b>	EUR 280,000
<b>Payback period</b>	8 years
<b>Project Results</b>	<ul style="list-style-type: none"> <li>➤ 80% final energy savings</li> <li>➤ 79% CO2 emissions reduction, what is equal with 133 tones of CO2 reductions per year.</li> </ul>



## Hotel Dacia, energy efficiency criteria

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### Characteristic data:

U-Value

### Criteria:

External walls / temperature difference  
more than 10 K

Walls:  $\Delta U < 0.60 \text{ W/m}^2\text{K}$

Roof:  $\Delta U < 1.00 \text{ W/m}^2\text{K}$

Floors:  $\Delta U < 0.40 \text{ W/m}^2\text{K}$

New windows:  $U_{wo} \leq 2.1 \text{ W/m}^2\text{K}$

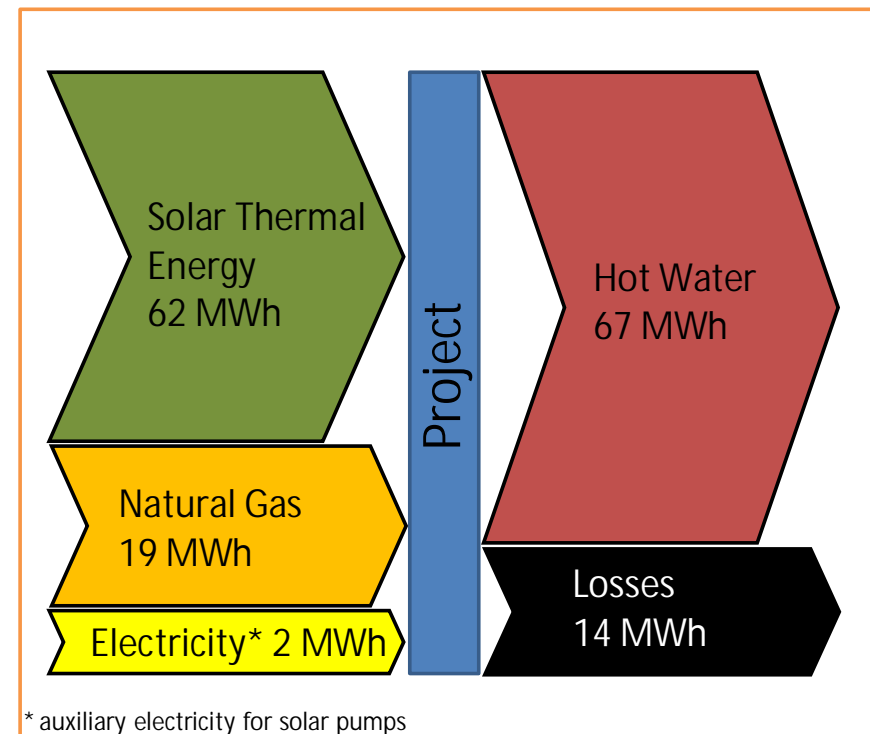
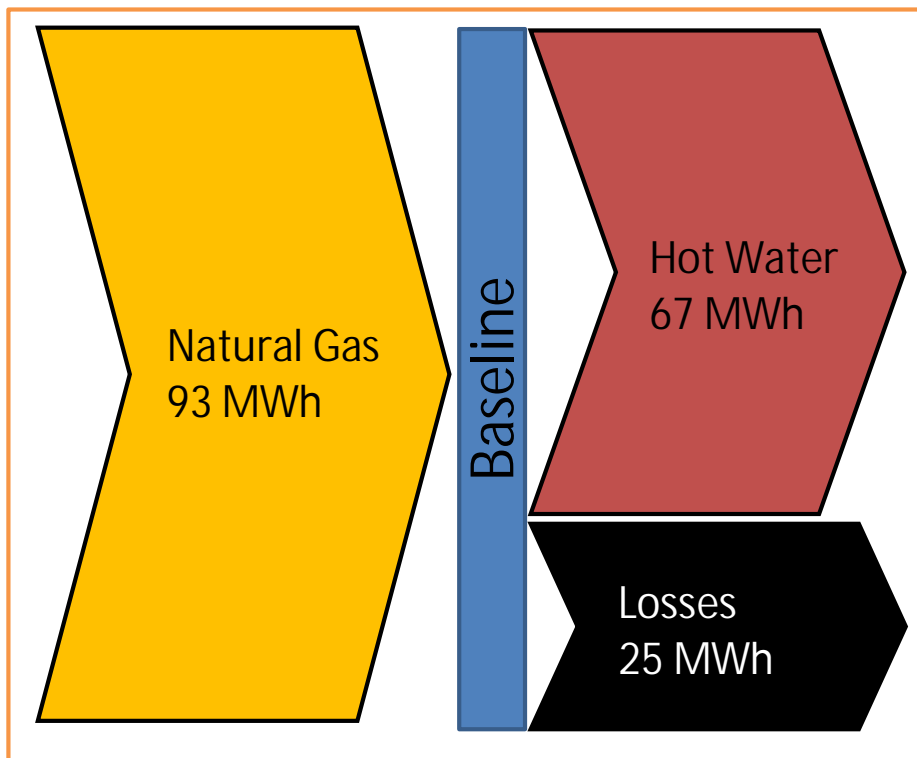


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## Hotel Dacia, energy flow (water heating system)

Baseline (old system)

Project substitutes natural gas  
by solar heat



# Feasibility Study – Hybrid Power Plants

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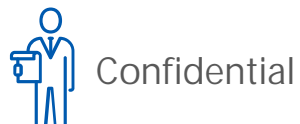
## Drawing up specifications and tender documents, Germany

In the Philippines as in other countries in the region and around the world PV-solar hybrid systems have become a cost effective alternative solution to provide electricity to off-grid areas. The Philippine government is preparing to tender out a number of off-grid generation systems in remote areas of the countries as well as on islands.

Fichtner is conducting feasibility studies and concept design considering the optimum system configuration of a generation power plant in off-grid area required for each of the projects and prepare Minimum Functional Specifications (MFS) for each of the projects.

For each off-grid hybrid system Fichtner will consider the existing Diesel generators in a combination with new PV, possibly wind and storage plants. Other technologies may be considered case by case. Using Fichtner's own certified hybrid optimization software the best configuration will be determined. For the final selected solution a basic design will be elaborated. Levelized Cost of Electricity (LCOE) as well as CAPEX and OPEX will be calculated.

As a basis for future tendering of the hybrid power generation systems Minimum Functional Specifications as well as Hybrid Performance Guarantees will be prepared.



11.2017 – 03.2017



12 sites:

PV: 49 MW

Storage: 16 MW / 35 MWh

Diesel: 135 MW

# Design of Renewable Hybrid Plants (VDE-PB-014-1:2015)

## I. Assessment of site conditions


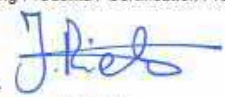
- Existing and conventional power stations
- Grid and load analysis
- Resource assessment (solar, wind, geothermal, biomass, etc.)


## II. Technical Simulation

- Yield simulations of renewable energies
- Hybrid power plant model incl. load and conventional power systems
- Simulation over operation period

## III. Techno-Financial Optimization

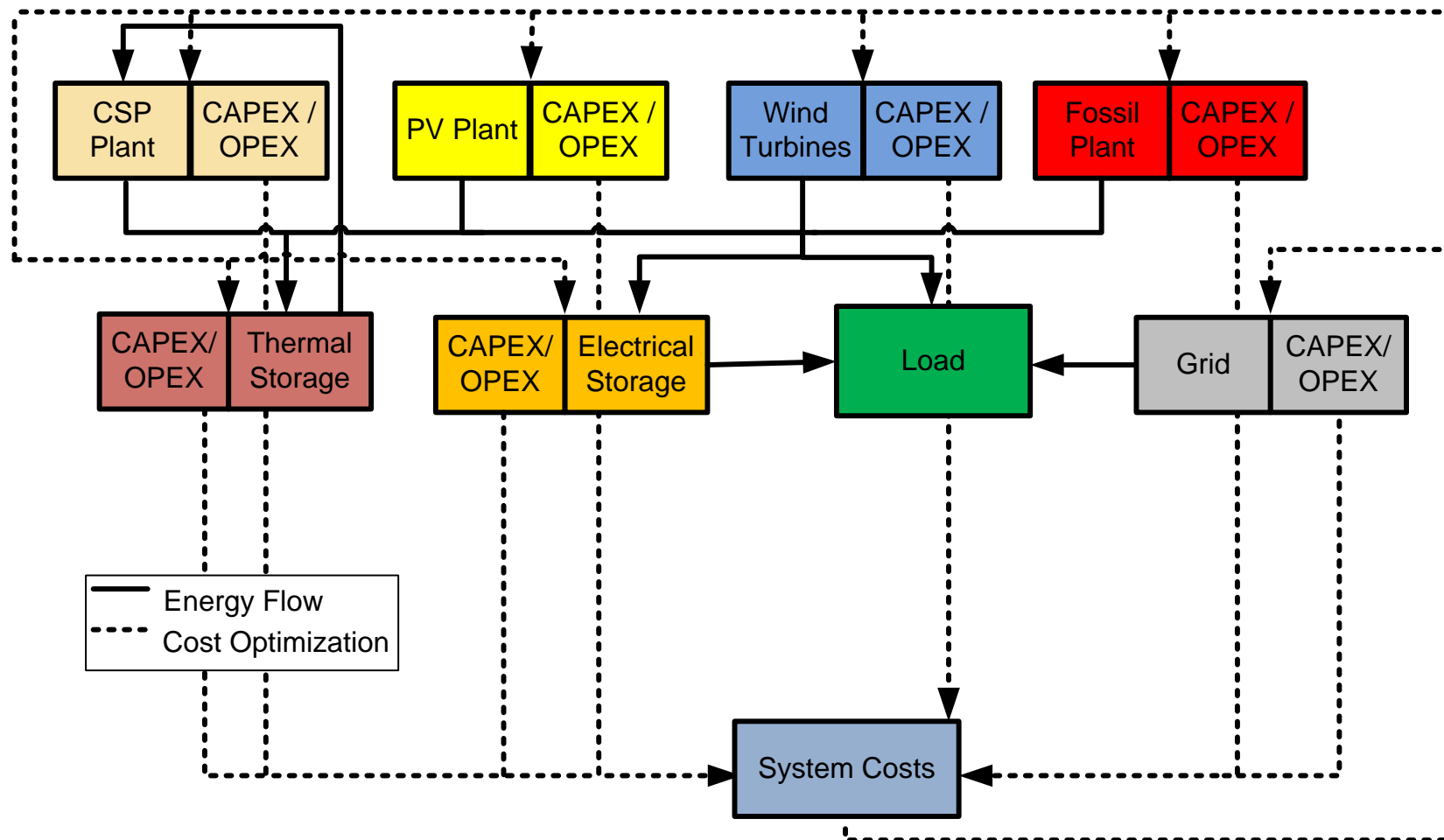
- Calculation of financial parameters (NPV, IRR, LEC, Payback) with dynamic cash flow model
- Optimizing technologies, sizing and operation to achieve highest financial benefits

 <b>KONFORMITÄTSBESTÄTIGUNG</b> <b>STATEMENT OF CONFORMITY</b>	
Produkt Product	Zubehör für Photovoltaik-Anlagen Accessories for Photovoltaic-Systems
Typenbezeichnung Model/Type reference	Fichtner Hybrid Configurator
Betriebsdaten und Merkmale Rating and principal characteristics	Prozess, Methode und Software für die Simulation von PV-Hybrid Systemen Process, Method and Software for PV-Hybrid system simulation
Hersteller Manufacturer	Fichtner GmbH & Co. KG Sarweystraße 3 70191 Stuttgart Germany
Geprüft im Auftrag von Tested by request of	Fichtner GmbH & Co. KG Sarweystraße 3 70191 Stuttgart Germany
<p>Auf Basis einer einmaligen Untersuchung eines oder mehrerer Produktmuster wird die Übereinstimmung mit den Anforderungen der nachfolgend aufgeführten Prüfgrundlage bestätigt. Detaillierte Ergebnisse sind dem Prüfbericht zu entnehmen. Based upon a single test of one or several product samples, compliance with the requirements of the following test basis is confirmed. Detailed results are provided in the test report.</p>	
Prüfgrundlage Test basis	VDE-PB-014-1:2015 (Part 1) – Procedure for load measurements and extrapolation (Conform with procedure A) VDE-PB-014-2:2015 (Part 2) – Minimum technical requirements for simulation input: Generators (Conform with procedure A) VDE-PB-014-3:2015 (Part 3) – Minimum technical requirements for simulation input: Energy storage (Conform with procedure A) VDE-PB-014-4:2015 (Part 4) – Minimum technical requirements for simulation software and procedure for simulating fuel savings
Aktenzeichen File number	5022690-3970-0001/235829
Prüfbericht Test report	235829-ET2-1
ID Nummer ID number	40045958
<p>Diese Konformitätsbestätigung berechtigt nicht zur Nutzung eines markenrechtlich geschützten Zeichens des VDE. This statement of conformity does not authorize to use any of the legally protected VDE marks.</p>	
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<p>Merlinstraße 28, 63069 Frankfurt am Main, Germany phone +49 69 6306 0, fax +49 69 6306 555 e-mail: vde-institut@vde.com, www.vde-institut.com VDE Zertifikate sind nur gültig bei Veröffentlichung unter: <a href="http://www.vde.com/zertifikat">www.vde.com/zertifikat</a> VDE certificates are valid only when published on: <a href="http://www.vde.com/certificate">www.vde.com/certificate</a></p>	





## Fichtner Hybrid Configurator



# Exemplary Hybrid Project: Dairy farm in Saudi Arabia

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## Project Background

- 75,000 cows at 30-50°C in the Arabian desert
- Peak electrical demand between 75 – 100 MWe
- Heating and Cooling demand for milk processing
- Currently powered by multiple 4-8 MW diesel generators
- LFO price today at 12 USDct./liter

## Challenge

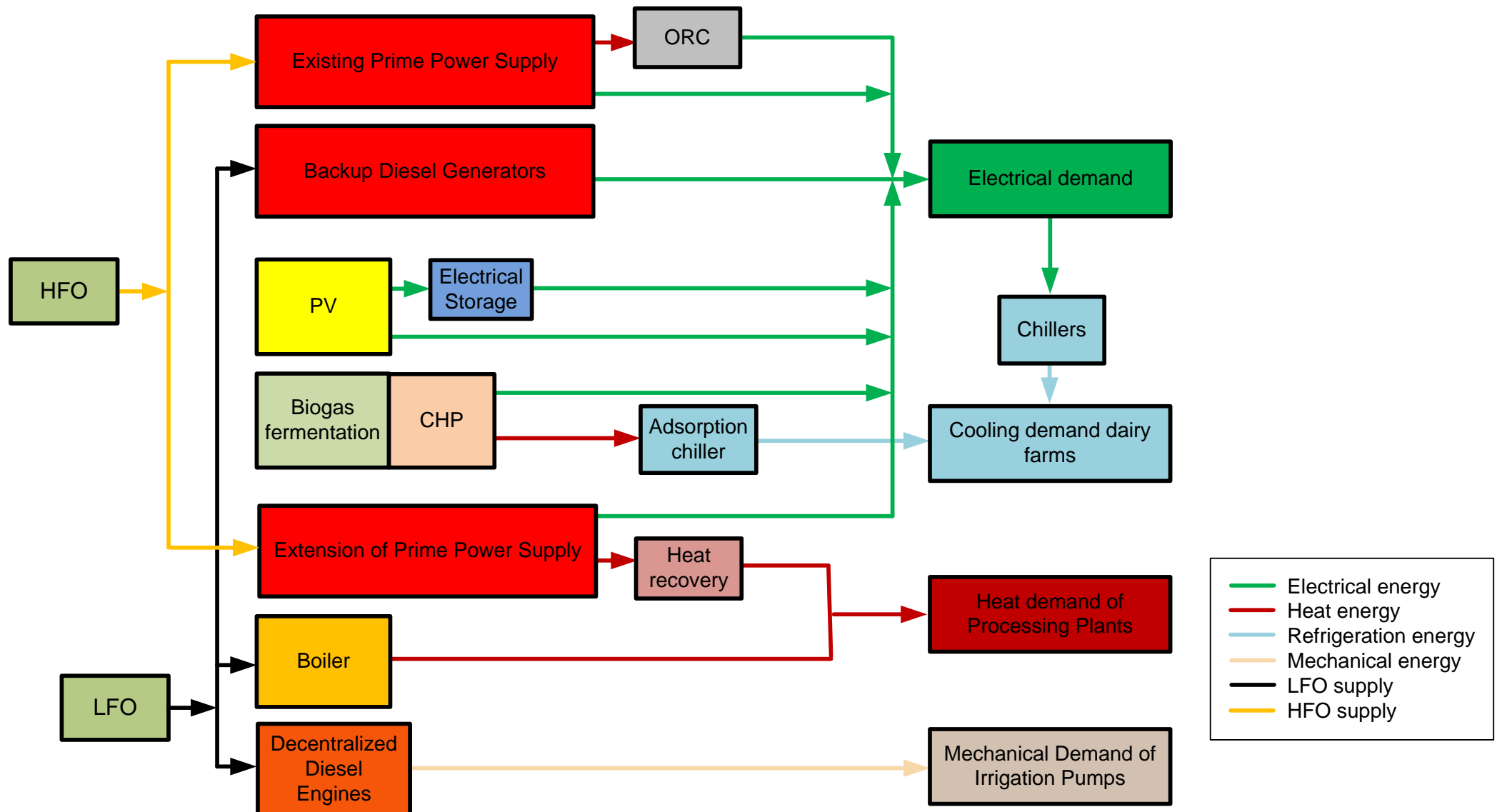
- Increasing production and demand of energy
- Fuel price increase
- Fuel budget limitation
- Manure disposal

## Hybrid Project Solution

- Save fuel
- Increase maximum power output
- Implementation in stages until 2022



# Energy Concept





# Conventional Diesel generators

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## Diesel Generator specifications:

- 8 x 8 MW engines (Prime) running on HFO
- 48 MW Back-up generators distributed over Dairy farms running on LFO



## Objective:

- Main power supply
- Active and reactive power control
- Ramp rate + frequency control
- Peak power supply
- Back-up power



## Generation costs:

- HFO: 3.1 USDct./kWh
- LFO: 4.9 USDct./kWh

# Organic Rankine Cycle Plant

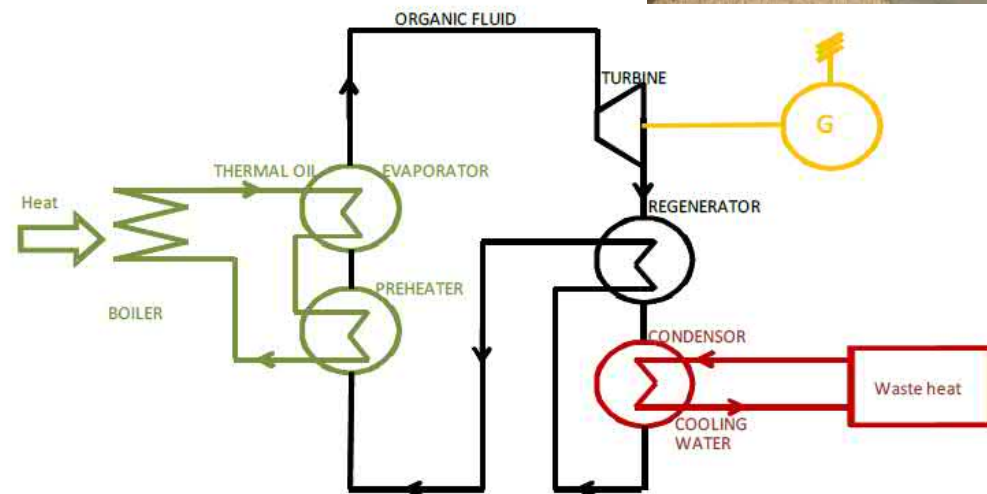
## ORC specifications:

- Heat recovery of diesel engine exhaust
- ORC Module (Turbine + Thermal oil circuit) 4.8 MWe (8 x 600 kWe)
- Air cooled condenser existing from diesel generators

## Objective:

- Increasing electrical efficiency of main diesel engines (Reduce fuel consumption also at partial loads)
- Increase maximum power output

Generation costs: 4.5 USDct./kWh



# Diesel engines for CHP

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## New diesel engines for CHP specifications:

- 8 MWe Diesel engines (For HFO + LFO) (2 engines Stage I + 3 engines Stage II)

## Objective:

- Provision of Electricity
- Increase maximum power output
- Provision of ramp rate + frequency control
- Provision of Heat (Steam 200 °C, 8 bar)

## Interfaces:

- Switchgear at Processing Power Plant
- Steam interface at Boiler Plant

**Generation costs:** 3.2 USDct./kWh (heat not included)





# PV Plant

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## Objective:

- Provision of electricity (active + reactive)
- Increase maximum power output during day
- Save diesel fuel

## Specifications:

- 40 MVA (Stage I) + 50 MVA (Stage II)
- DC/AC ratio: 1.1

## Interfaces:

- Switchgear at Main Power Station

## Generation costs:

- 1-axis tracked: 4.65 USDct./kWh
- fixed: 4.85 USDct./kWh



# Biogas Plant

## Objective:

- Provide electricity (Base load) and save diesel fuel
- Provision of Cooling energy
- Provision of Fertilizer
- Disposal of manure

## Specifications of Biogas Plant:

- 6.3 MWe (splitted into 2 locations)
- Adsorption Chiller and circuit at Dairy farm
- Interconnection to 34.5 kV at Dairy farm

## Interfaces:

- Power connection
- Cooling circuit at Dairy farm
- Fertilizer at Compost area

Generation costs: 14 USDct./kWh (cooling not included)



Source: DVO Anaerobiv digesters



# Electrical Storage

## Objective:

- Increase of maximum power output
- Provision of reactive power
- Provision of spinning reserve (bridging the time the diesel generators need to start up to avoid inefficient reserve capacity)
- Firming of short-term fluctuations of PV (e.g. clouds, sand storms) until ramp rate capabilities of the diesel generators
- Load shifting of PV energy production to increase PV utilization
- Black-start capability

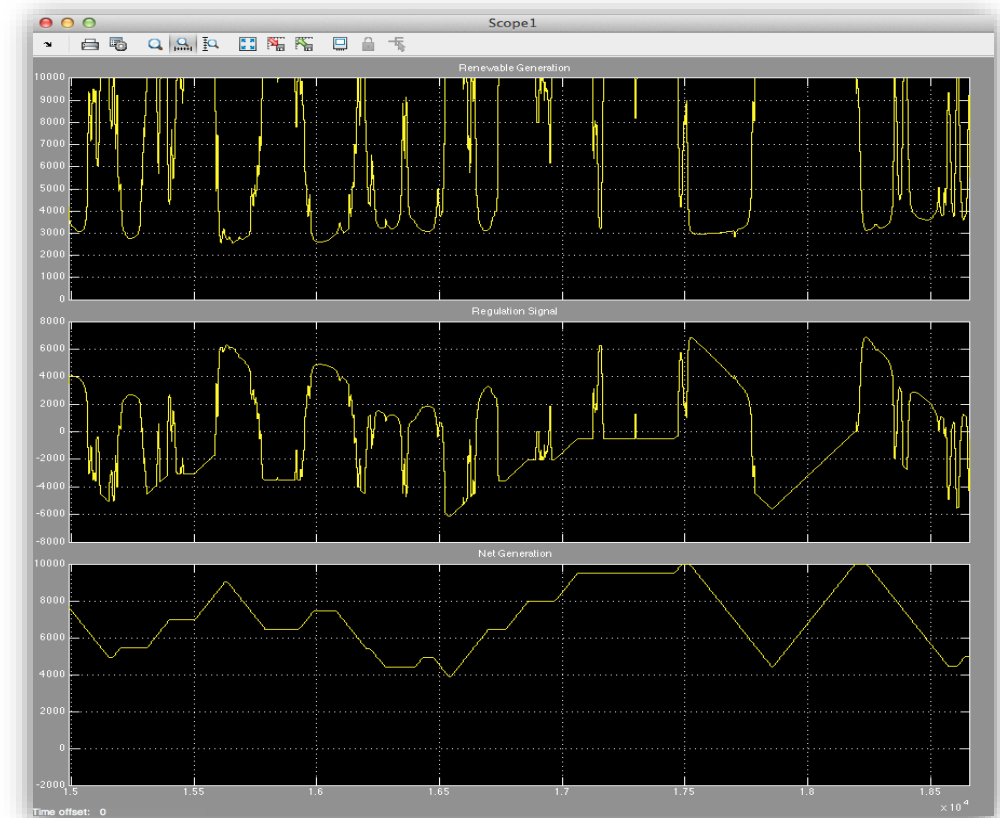
## Specifications of Storage:

- Lithium-ion technology
- 50 MW / 25 MWh (Final Stage)

CAPEX assumption: 28 mio. USD (2016)



Source: A123 Systems





## Lessons learned in Hybrid Projects

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Hybrid Project Challenges	Project Risks	Solutions / Mitigations
Off-taker has doubts of benefits	No management board decision on execution	Feasibility study certified to VDE-PB-0014:2015, Implementation in stages
High RE share desired	Supply reliability, low utilization	Conventional plants still required, Electrical storage
Developers with expertise in all technologies	Plant optimization difficult, low competition, technical difficulties	Strict MFS, separate EPC expertise requirements, dispatch experience requirements
Performance guarantees for off-taker (fuel provided by off-taker)	High operational costs / risk for developer depending on load and resource conditions	Separate performance tests of plants, dispatcher tests
Investor risks of feed-in interaction	No financing or high financing rates	Split of payments and deemed energy payments for curtailment