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**Waterleau BV**, a mesophilic anaerobic digestion plant in Ypres (80 km west of Ghent), West-Flanders, Belgium, in operation since 2012 with a total annual substrate treatment capacity of 120,000 t. Processing manure and biowaste.



**Fridays Ltd.**, a mesophilic anaerobic digester at Knoxbridge Farm, Frittenden, Cranbrook, Kent, United Kingdom, currently under construction with a total annual substrate treatment capacity of 60,000 t. Planned to process poultry litter and straw (photo of an existing DVO plant in USA).

**Nurmon Bioenergia Ltd.**, a mesophilic anaerobic digester in Seinäjoki (80 km southeast of Vaasa), South Ostrobothnia, Finland currently under construction with a total annual substrate treatment capacity of 240,000 t. Planned to process manure, industry by-products and plant biomass.

The business cases represent large-scale biogas activities owned and, typically operated by small and medium enterprises (4-9 M€ sales, 10-30 employees) servicing the farming and food industry sector. Plants are located in high livestock density regions (Flanders/Belgium, The Netherlands), in regions with moderate livestock density (Finland, Germany, UK) and low livestock density (Italy). A variety of feedstock is used including manure, poultry litter, agricultural waste, food industry waste, source separated domestic food waste and sewage sludge. By far the most important source of revenues is energy supplies paid by feed-in tariffs, feed-in premiums, and green certificates. In contrast to the other plants, Acqua e Sole in Italy generates most of its revenues from gate-fees for processing municipal sewage sludge.

The report explains the nature and function of KPIs in general and their intended function in business cases present in SYSTEMIC.

In the second chapter the approach and KPI development is explained. SYSTEMIC aspires to develop model business cases for anaerobic digestion and nutrient recovery and recycling in a Circular Economy



(European Commission, 2018). The relevant policy (European Commission, 2017) and legislative (European Union, Parliament and Council, 2018) framework as well as the energy mix options in a low or net-zero carbon emission EU-2050 (European Commission, 2018) have been analysed and exhibited in the *Business Case Evaluation Report*, published in September 2019<sup>1</sup>.

Apart from the apparent use of EBITA- (earnings before interest, tax and amortisation) and EBIT- (earnings before interest and tax) margins measuring the overall profitability of a business, three case specific KPIs have been derived from the main material and energy flows of the anaerobic digestion plants providing indicators for

- Overall substrate financial productivity measuring the overall financial productivity of substrates, i.e. total revenues per ton of substrate processed in EUR/t.
- Energy related financial productivity measuring the energy related financial productivity of biogas, i.e. the net revenues from energy supplies per m<sup>3</sup> of biogas in EUR/m<sup>3</sup>.
- Digestate related financial productivity measuring the digestate related financial productivity of substrates, i.e. net costs (revenues) of products (digestate, recycled products) per ton of feedstock processed in EUR/t.

Because of irrelevance for the purpose of developing business models, KPIs related to the internal cost centres of the companies are not considered but they may be added at a later stage of the project.

In chapter 3 the financial performance of SYSTEMIC partner plants is analysed by application of the five KPIs. Every plant (except Fridays) is compared to the median of all seven SYSTEMIC partner plants for every indicator, plainly exhibiting the differences in terms of approaches and performances. KPIs have proven to be useful highlighting the areas of activity that contribute to the profitability and those that do not. Furthermore, KPIs can help the management identify the areas that should be further assessed for improvement options. All plants have relevant costs related to the handling and disposal of digestate, even after implementation of NRR systems.

As another direct result from the performed KPI development, recommendations for strategic options to be pursued during the remaining project life, about 18 months, have been included. As all plants may improve their overall profitability by productisation and marketing of recycled products, this will become a common project task. Yet, most business cases are already quite profitable and the improvements are not urgently needed. Actually, the business cases can already be used as a role model for anaerobic digestion plants due to mostly using organic waste based feedstock and having implemented the equipment for effective product recycling. NRR systems are in all cases contributing to the profitability, clearly exhibited by the two cases that have operated conventional digesters until recently.

In chapter 4 all seven plants are compared and the overall results are evaluated. The direct comparison of the measured results facilitates positioning of the own business vis-à-vis the "competitors", albeit operating under different framework conditions. The comparison of AM-Power and Groot Zevert, before and after NRR implementation is also exhibited in chapter 4.

Chapter 5 draws the conclusions.

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<sup>1</sup> Hermann, L. and Hermann, R., 2019, Business Case Evaluation Report. Ed.: Wageningen Environmental Research 2019, in press

# 1 What is a Key Performance Indicator?

Literature offers various definitions of KPIs and you can find a Web-Site called [www.kpi.org](http://www.kpi.org) managed by the Balanced Score Card Institute, located in North Carolina and offices in several countries outside the US. The approach proposed by KPI.org is starting by formulating the objectives and strategy. The web-site offers a guideline on how to develop and use KPIs for an individual organisation. Other definitions are:

- KPI is "A quantifiable measure used to evaluate the success of an organization, employee, etc. in meeting objectives for performance" (Oxford Dictionary).
- KPI is a tool to understand how an organisation is performing. It must be quantifiable and essential for achieving goals. Frequently KPIs are associated with targets and aim at quantifying their achievement. In the context of the SYSTEMIC project, KPIs are understood as a pillar of the organisations performance management system and are intended to find out which targets the organisations should set and pursue (Boston Consulting Group, 2017).
- The British Companies Act 2006, section 417/6 requires KPIs to be reported in the annual reporting of medium-sized companies: "Key performance indicators" means factors by reference to which the development, performance or position of the business of the company can be measured effectively" (PriceWaterhouseCoopers, 2007).

KPIs may be designed to measure all kind of aspects in a business like sustainability, materials efficiency, customer satisfaction, employee performance, etc. For this report, the focus is on KPIs measuring the financial performance of the business answering a few simple questions:

- Is the business profitable
- Which business activities (cost centres) are significantly contributing to the profitability of the company
- Which business activities are underperforming and undermining the profitability of the company and
- What are the best metrics to measure the performance.

KPIs depend on business types and priorities. Different organisations will select different KPIs and even within one organisation business areas, departments and projects may choose different KPIs. The choice fully depends on individual targets. Hence, every project or department will measure its performance against its own financial, marketing, sales, service, supply or manufacturing KPIs. Meaningful KPIs allow leaders to evaluate how well the business is doing and which changes may improve the performance. They can also provide early warnings about sectors critically underperforming.

Literature distinguishes between lagging KPIs that are tracking the past performance and leading indicators dealing with future outcomes. In addition, organisations can use quantitative indicators measuring results by numbers and qualitative indicators leaving more room for interpretation. Attention must be paid to select relevant KPIs that are measuring business critical parameters and selectig the right number – too many KPIs can distract the management from the processes having a real impact on the business performance. Once KPIs are introduced they should be continuously evaluated to remain aligned with the priorities of the organisation.

Commonly used KPIs are measuring expenses and profit, gross and net profit margins, material and financial productivity, return on investment, total costs of products sold, annual uptime of facilities and equipment, specific energy and/or material consumption, material use efficiency, recovery and recycling rates, emissions to air, soil and water, cost of acquiring new customers, turnover of inventory, turnover per employee, turnover per square meter shop area, rate of defective products, rate of returns, customer satisfaction, employee satisfaction, number of accidents per working hour and many others. Everything that can be measured or at least interpreted with common sense can be used as a KPI.



## 2 Anaerobic Digestion Business Cases and KPI Development

The anaerobic digestion business depends on regional and national framework conditions that distinguish one case from another. It is essentially a service business, has elements of a utility (supplying energy) and may handle large quantities of materials containing high mass fractions of water.

Essentially, anaerobic digestion (biogas) plants deal with processing three relevant in- and output flows (feedstock, energy, digestate) that may generate revenues or costs:

- (1) Organic waste flow (substrate) processing – a service to farmers, industries, municipalities, wastewater treatment plants and others. The corresponding revenue is typically a gate-fee. The gate-fee depends on multiple factors (regional market, legislation, type of substrate, content of volatile, conversable organic matter, water content). However, the substrate can also have a price (if delivered by third parties and regardless of being a waste or by-products) or a cost (in case of energy or cover crops grown by the owner/operator of the anaerobic digestion plant). Regardless of the substrate having a price or an internal cost, the initial value is negative. Availability and characteristics of the substrate can have a significant influence on the P&L accounts of the operating company and is therefore a meaningful KPI reference value. In addition, availability of substrates, i.e. feedstock for digesters, is key to developing a digester business. Hence, biogas business development usually starts with the search for digestible organic feedstock.
- (2) Conversion of substrate to energy – a service to the public at large or to specific sectors like the industry (e.g. dairy plants) or transport (e.g. heavy good vehicles) sector. Energy supplies are usually the most important sources of revenues of biogas plants and they are frequently fixed in a multiannual contract in form of feed-in tariffs, feed-in premiums, or green certificates. Regardless of these characteristics, the operator still has instruments to improve the energy revenues, e.g. by adapting their business case to available bonuses by increasing the conversion efficiency (making best use of secondary energy flows like heat), increasing the supply flexibility to better adapt the business to its role as stabilising factor in an environment of highly volatile energy supplies by solar energy and wind and selecting the type of energy the biogas plant is selling – biogas, electricity, biomethane, bio-LNG or bio-CNG. Energy supplies always generate revenues, albeit, in absence of support schemes, quite small ones that do not cover operations of a biogas plant.
- (3) Processing the digester effluents and selling them as a re- or upcycled product – the focus area of SYSTEMIC. Currently, the management of digester effluents typically causes operations costs (OPEX), sometimes very relevant ones. Some SYSTEMIC business cases have the advantage of cropland under the company's management. When using the fertilising by-products for the own production of agricultural products, operators save the equivalent amount of nutrients supplied by third parties and the corresponding costs. In this case, the cost of the nutrients in the market (if any) can be accounted as a benefit in the P&L account. When operators have to sell the by-products at the free market, they currently receive only a fraction of the typical market value of nutrients. In every SYSTEMIC business case, processing the nutrients saves costs and has a relevant impact on the P&L account.

For the purpose of the SYSTEMIC business case evaluation and for providing suitable tools for self-assessment of the owners/operators, deriving finance related KPIs from the revenue and/or cost streams described above was considered most appropriate. In addition, the simple KPIs EBITA margin and EBIT margin were selected to measure the overall business performance. The EBITA margin makes the OPEX of biogas-based business cases comparable as it does not include the arbitrarily set factor amortisation time and the interest rate. Amortisation time in accounting usually differs a lot, depending on prevailing accounting rules and on management decisions – in case of SYSTEMIC the range goes from 3 years (for peripheral nutrient recovery systems) to 20 years (for the whole biogas plant).

After identifying business areas which may be considered cost centres common to all AD plants, Key Performance Indicators can be developed. KPIs should be measurable and reportable without many additional efforts by operators and the management.

## 2.1 Definition of "SYSTEMIC" KPIs

The two KPIs defining the overall financial performance of anaerobic digestion plants are key indicators reported in every profit and loss (P&L) statement: EBIT- (earnings before interest and tax) margin and EBITA- (earnings before interest, tax and amortisation) margin, the ratios of a company's operating income to net revenues, presented in percent. The EBITA margin measures only operating cash-flows while the EBIT margin takes the effect of amortisation into account. Both indicators exclude the interest and tax rates and facilitate the overall comparison of the financial results of seven investigated plants. In addition, they facilitate to assess the overall business performance of the activity in comparison to other activities for managers, investors, and bankers in case of loan financing. However, EBITA and EBIT margins and EBIT do not help the management to identify the levers to pull to improve the business performance. For this purpose, other indicators need to be determined.

Following the approach of deriving metrics from the main revenue/cost items of an anaerobic digestion plant, the task is to identify relevant and quantifiable indicators that are key to the financial performance of the businesses.

As KPI related to organic substrate processed by the plant the "*financial substrate productivity*" per mass unit – tonne - is proposed. The financial substrate productivity is calculated as revenues in Euro per tonne of substrate whereby revenues can be generated by gate-fees, energy supplies and products.

As KPI related to energy conversion "*financial productivity of biogas*" per volume unit – cubic meter – has been determined. This indicator allows the assessment of the different potential types of energy outputs of a biogas plant: biogas, electricity and biomethane including bio-LNG and bio-CNG. Heat is an accountable energy output but usually consumed internally.

As KPI related to digestate "*financial digestate productivity*" per mass unit – tonne – has been selected. This indicator facilitates the assessment of costs (in most cases) or revenues (the long-term objective of NRR systems) of the financial flows associated to the handling and disposal of digestate or derived products. It allows a comparison of the financial flows before and after installing an NRR system.

The five selected KPIs allow assessment and comparison of different strategies and options of managing and operating an anaerobic digestion plant. Each revenue or cost carrier – substrate, energy, digestate – is represented by one individual KPI by which the specific "carrier" performance can be measured.

Both, substrate and digestate financial productivity are related to the total mass of substrate processed. If digestate financial productivity were measured by tonne of digestate, changing the mass/volume flows could produce deceptive results. Substrate financial productivity can be affected by changes in substrate management (e.g. other types, other suppliers), changes in energy supplies (e.g. biomethane instead of electricity, biogas storage for higher flexibility) and changes in digestate management (e.g. by NRR). However, if both individual values remain unchanged, one can clearly discern the effect of a substrate related measure.

By calculating a median KPI value for each of the selected indicators, a benchmark is set to compare the performance of one AD plant to the other AD plants of a selected group – for this report the median of partner plants. Owners/operators realise in which sector their plant performs better or worse than the peer group and can analyse the reasons. This instrument is a valuable metrics for all AD plants dealing with this report. The sector specific performance of AD businesses can be calculated and compared.

Selected KPIs only refer to external relations with suppliers and customers. In general, KPIs could also measure internal targets but for the purpose of evaluating SYSTEMIC business cases we do not consider internal plant processes and issues for obvious reasons of confidentiality of related information.

Nonetheless, indicators discussed in this report can still be used for analysing internal costs an individual business case. If the selected KPIs for substrate, digestate and biogas financial productivities are at or

above median of SYSTEMIC participants and EBIT or EBITA are far below and even negative, it is an indicator of excessive internal costs. In this case, businesses should dive deeper into their internal structures and expenses for maintenance, repair, personnel, travel, representation, and whatever other cost position may stand out in comparison to the peer group.

Table 2.1.1 KPIs, metrics and related business relevant information

KPI #	Name	Unit	Explanation
1	EBITA margin	€ EBITA / € revenues in %	Overall operational financial performance of businesses (excl. interests and amortisation) in percent of revenues
2	EBIT margin	€ EBIT / € revenues in %	Overall operational and capital expenses related financial performance of businesses (excl. interests) in percent of revenues
3	Substrate financial productivity EUR total revenues / tonnes substrate	€ / t	Measures the overall substrate related financial productivity, i.e. total revenues (turnover) of the plant per ton of feedstock processed.  Indicator of the overall financial productivity of processed substrates regardless from which activity (cost centre) of the digestion plant.
4	Digestate financial productivity EUR digestate costs (revenues) / tonnes substrate	€ / t	Measures the digestate related financial productivity of substrates, i.e. net costs (revenues) of effluents or products (digestate, recycled products) per ton of feedstock processed.  Indicator for the costs or revenues of handling/disposing of or selling the solid and liquid materials coming out of the digester which are affected by NRR systems and use/sale of recycled products.
5	Biogas financial productivity EUR energy revenues / cubic meters biogas	€ / m <sup>3</sup>	Measures the energy related financial productivity of biogas, i.e. the net revenues from energy supplies per m <sup>3</sup> of biogas supplied.  Indicator for the revenues generated from a given biogas output and affected by the type of final energy carrier supply (electricity, bio-methane, bio-LNG or bio-CNG) and support schemes (feed-in tariff, feed-in premium and other energy supply related revenues).









Table 3.1.2.3 AM-Power KPIs

KPI #	Type / Description	Unit	Reference value	KPI Result	Median values <sup>*)</sup>	Comment
1	EBITA margin	€ EBITA / € revenues in %	1,893,289 €	25%	41%	Much below median EBITA margin
2	EBIT margin	€ EBIT / € revenues in %	201,492 €	3%	12%	Much below median EBIT margin
3	Substrate financial productivity EUR total revenues / tonnes feedstock	€ / t	171,000 t	44.50 €	53.38 €	Medium low financial substrate productivity
4	Digestate financial productivity EUR digestate handling / tonnes feedstock	€ / t	171,000 t	-7.25 €	-5.35 €	Medium low negative digestate related results
5	Biogas financial productivity EUR energy supplies / cubic meters biogas	€ / m <sup>3</sup>	30,000,000m <sup>3</sup>	0.24 €	0.36 €	Below median energy related results

<sup>\*)</sup> Median values refer to seven SYSTEMIC partner anaerobic digestion plants

The suggested strategy for AM-Power is reviewing the substrate purchasing contracts and trying to improve the feedstock related KPI. Reducing the cost of feedstock would have an impact on the KPIs financial substrate productivity, EBIT and EBITA and make the business case much more resilient. In addition, it may have an immediate effect. The improvement of the digestate/product related KPI is another area for improvement but is supposed to take longer until the business case will become more robust.

### 3.1.3 BENAS GmbH

A thermophilic anaerobic digestion (AD) plant in Ottersberg (40 km east of Bremen), Lower Saxony, Germany, in operation since 2006 with a total annual substrate processing capacity of 174,000 t. Processing corn silage, plant residues and poultry litter.

*Table 3.1.3.1 BENAS Plant characteristics*

Date of commissioning	2006
Annual substrate processing capacity / processed	174,000 t / 102,000 t (82 kt corn & plant residues / 20 kt poultry litter)
Installed electric capacity (IEC)	11.3 MW
Installed biomethane capacity	1,200 m <sup>3</sup> /h
Digester volume	26,000 m <sup>3</sup>
Annual biogas output / biogas per t of feedstock	20 Mm <sup>3</sup> / 194 m <sup>3</sup> /t
Annual electricity net-output (fed to the grid)	26,972 MWh (23,610 MWh <sub>el,tot</sub> + 25,580 MWh <sub>heat</sub> )
Annual bio-methane output	8.78 Mm <sup>3</sup> (1,200 m <sup>3</sup> /h)
Digester type	Thermophilic Continuous Stirred-Tank Reactor (CSTR)
Nutrient recovery & recycling (NRR) facilities	FiberPlus ammonium stripping system Screw press for solid/liquid separation Rotary drum dryer for digestate
NRR Products	Hygienised dewatered / dry digestate Ammonium sulphate (3,700 t/a) Calcium carbonate (1,000 t/a) Hygienised, dry digestate / fibres
Framework conditions relevant to the business case	Biogas storage capacity 39,000 m <sup>3</sup> Owners cultivate 3,500 ha agricultural land, 2,000 ha about 200 km distant from biogas plant Double IEC for full flexibility Desulphurisation gypsum used for ammonium sulphate production FibrePlus system for future production of fibres

The KPIs are derived from the plant characteristics shown in table 3.1.3.1 above and the P & L summary shown in table 3.1.3.2 below.

*Table 3.1.3.2 BENAS P & L summary in EUR*

BENAS	Revenues	Expenses	Balance
Substrates (biowaste, manure, energy crops)		3,016,626	-3,016,626
Energy and Green Certificates	7,920,373	398,400	7,521,973
Product sales / savings	277,160		277,160
Consumables (chemicals, spare parts)		17,604	-17,604
Digestate & NRR product handling (storage, application)		374,430	-374,430
Operations (personnel, overhead, maintenance, repair)		1,450,000	-1,450,000
Amortisation (12 years)		1,850,000	-1,850,000
	8,197,533	7,107,060	1,090,473
<b>EBITA (Earnings before interest, amortisation, and tax)</b>		<b>2,940,473</b>	<b>EBITA Margin 36%</b>
<b>EBIT (Earnings before interest and tax)</b>		<b>1,090,473</b>	<b>EBIT Margin 13%</b>

BENAS gives a good example for how a very low substrate related performance is totally off-set by a very high energy productivity leading to the highest financial substrate productivity in the SYSTEMIC group. BENAS' KPIs are all above median except the EBITA and EBIT. However, this may be due to

relatively high costs of consumables and personnel. Since the business case is profitable and highly resilient due to the flexibility in terms energy conversion and use of products (KPI also much above median), mainly gradual improvements along the same strategy line are suggested.

Table 3.1.3.3 BENAS KPIs

KPI #	Type / Description	Unit	Reference value	KPI Result	Median values <sup>*)</sup>	Comment
1	EBITA margin	€ EBITA / € revenues in %	2,940,473 €	36%	41%	Below median EBITA
2	EBIT margin	€ EBIT / € revenues in %	1,090,473 €	13%	12%	Slightly above median EBIT
3	Substrate financial productivity EUR total revenues / tonnes feedstock	€ / t	102,000 t	80.37 €	53.38 €	Very high financial substrate productivity
4	Digestate financial productivity EUR digestate handling / tonnes feedstock	€ / t	102,000 t	-0.95 €	-5.35 €	Slightly negative digestate related results – the best among the operational AD plants
5	Biogas financial productivity EUR energy supplies / cubic meters biogas	€ / m <sup>3</sup>	20,000,000 m <sup>3</sup>	0.38 €	0.36 €	Above median biogas productivity

\*) Median values refer to seven SYSTEMIC partner anaerobic digestion plants

The suggested strategy for BENAS is to continue with gradual improvements, for instance in trying to reduce the feedstock cost which may be a consequence of replacing energy crops by waste materials. However, attention must be paid on keeping the high energy related performance and the very high substrate financial productivity.

As to the product strategy, continued efforts to productise the fibrous fraction of digestate that would not even impact the use as fertilising product – fibres will be nutrient free – should be a very promising pathway, in particular if the use of fibres in bio-degradable pots materialises.



























