Batch A

Voorblad Documenten 1 – 4

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Document 1

From: [redacted]
To: vincent eventures
Cc: [redacted]; PSI, Postbus
Subject: PSI12ZM21 verslag meeting 5 juli 2017
Date: vrijdag 7 juli 2017 12:32:51

Beste Vincent,
Dank voor jullie bezoek op 5 juli 2017 waarbij we de afronding van het Final Report hebben besproken.
We hebben een tweetal punten besproken.

1) De brief van RVO van 15 juni j.l.
2) WOB verzoek

Ad 1) De brief bestond uit 3 onderdelen, die zijn achtereenvolgens besproken.

a) MOVs niet volledig. Eventures gaf aan dat zij binnen afzienbare tijd meer bewijs kunnen aanleveren dat sub-results wel degelijk zijn behaald. Aantal voorbeelden genoemd: de farmers hebben een contract, het certificeringsrapport is aanwezig. Van aantal sub-results zijn activiteiten wel uitgevoerd, maar moeten de MoVs nog worden uitgewerkt. Vb het H&S rapport.
Voor RVO is **sub-result 5.1** belangrijk punt waar in Final Report onvoldoende bewijs is geleverd dat dit is behaald. RVO geeft aan dat innovatieve karakter van project uit twee elementen bestaat. De duurzame bouw en de duurzame mobiliteit (e-landy). RVO heeft nav het Final report de bouw van de lodge als voldoende beoordeeld en vindt dat er een mooi resultaat is behaald. Er is gebruik gemaakt van duurzame technologie ohgv zon PV, biogas, waterzuivering, sandbagbuilding en zonneboilers. Dit deel is cf het plan uitgevoerd. Eventures geeft aan dat het PSI budget uitsluitend is besteed aan innovatieve hardware. RVO geeft aan dat dit nu niet helder blijkt uit het budget, omdat *alle* hardware is opgevoerd. Eventures levert **aangepast PSI budget** op waarop alleen de innovatieve elementen staan.
Wat betreft de e-landy's heeft de producent EMKA aangegeven geen e-landy's meer te produceren. Het was een bedrijfsbesluit om productie niet door te zetten. Eventures heeft alternatieven gezocht, maar geen enkele partij voldoet aan kwaliteitseisen (vc. e-jeeps uit Zuid-Afrika). Eventures is geconfronteerd met overmacht. Zij hebben 1 e-landy vervangen door een e-boot. Aan RVO is niet helder gecommuniceerd dat het niet mogelijk bleek om aan sub-result 5,1 te voldoen. Eventures zal alsnog bewijs aanleveren dat zij door overmacht niet in staat zijn geweest meerdere e-landy's aan te schaffen. Daarnaast wordt de huidige e-landy wel ingezet voor safari's, net zoals de e-boot. Dit blijkt nu niet uit de overhandigde MoVs. E-ventures levert hier een rapport over aan. Zij geven ook aan dat zij de trend hebben gezet met het ontwikkelen van de eerste e-landy. Klanten zijn razend enthousiast. Maar de (productie) markt is er nog niet aan toe. Zodra de mogelijkheid zich voordoet wil Eventures e-landy's aanschaffen.

b) Marktverstoring. RVO heeft in oktober 2016 aangegeven dat zij aanvullende informatie wil ontvangen, om te kunnen beoordelen dat Ila Safari Lodge de markt *niet* verstoort. Dit nav contact met dhr Van der Heide die RVO meerdere malen heeft aangegeven dat hij last heeft van Ila Safari Lodge. De informatie die Eventures heeft aangeleverd in het Final Report geeft RVO nog onvoldoende houvast. Wel wordt duidelijk dat de bezettingsgraad laag is van Ila Lodge. Maar de

prijzen zijn niet inzichtelijk genoeg en ook is het voor RVO vanuit NL lastig beoordelen hoe de markt werkt in Kafue National Park. Eventures geeft aan dat er [redacted] lodges zijn en [redacted] bezoekers en dat er meer bezoekers nodig zijn, om meer park fees te kunnen innen van ZAWA en meer traffic te genereren om poaching tegen te gaan. Wat betreft proof dat Ila Lodge zich op een ander segment richt dan Mukambi Lodge geeft Eventures aan dat er tour operators zijn die aangeven blij te zijn dat er nu eindelijk een 5 star lodge is zodat zij hun gasten naar Kafue park kunnen onderbrengen ipv in een national park in een ander land. Dit geeft aan dat er met de lodge een nieuwe markt wordt aangeboord. Eventures zal **meer informatie verstrekken over de markt en het segment** waar Ila Lodge zich op richt.

c) Onjuiste, onvolledige informatie. RVO geeft aan dat zij niet op de hoogte was van de wijziging van 2 e-landy's naar 1 en dat zij niet akkoord is met diesel auto's in het budget. Eventures geeft aan dat dit in het hardware overzicht van 3 maart 2016 is aangegeven. RVO is van mening dat dit onvoldoende helder is gemaakt. Dit was een financieel overzicht en het stond niet in een inhoudelijke rapportage. Het werd voor RVO pas tijdens bezoek aan Zambia helder. RVO geeft aan dat dit voor haar een cruciaal element was voor innovativiteit van project. Omdat het een belangrijk onderdeel was van MOV 5.1 (zoals hierboven beschreven) had een wijzigingsverzoek moeten worden ingediend. Aanwezigen besluiten dat gewone landrovers/auto's worden geschrapt uit de HW lijst en concluderen dat hier sprake is van onduidelijke communicatie.

Conclusie

E-ventures zal reageren op vragen van RVO in brief van 15 juni en de nieuw gemaakte afspraken. RVO zal nieuwe stukken in redelijkheid en billijkheid beoordelen.
Ad 2) RVO heeft van Mukambi een WOB verzoek ontvangen. Omdat E-Ventures derde belanghebbende is, zal RVO haar alle informatie die zij ihkv de WOB openbaar moet maken, voorleggen. Eventures kan hierop reageren en aangeven (onderbouwd, RVO levert criteria aan) welke informatie zij niet openbaar gemaakt wil hebben. De WOB afdeling van RVO besluit uiteindelijk wat openbaar gemaakt wordt. Afgesproken is dat RVO de stukken volgende week aanlevert. Eventures zal per ommegaande reageren. RVO waardeert deze snelle medewerking.
Met vriendelijke groet,
[redacted]

Batch A

Document 2

RVO
T.a.v. [redacted]
[redacted]
Postbus 93144
2509 AC Den Haag

Naarden, 14 juni 2017

Betreft: **PS12ZM21, uw kenmerk: DPSI70721XFU, Pro forma bezwaar**

Geachte [redacted],

Naar aanleiding van uw schrijven d.d. 6 juni 2017, waarin u in reactie op mijn Final Report aangeeft dat sprake is van (deels) niet (volledig) gerealiseerde MOV's en deels incorrecte en incomplete informatie, op grond waarvan u mij in de gelegenheid stelt de deel resultaten tot 31 december 2017 aan te vullen, bericht ik u als volgt.

Ik deel uw conclusie dat op onderdelen de rapportage ten aanzien van enkele van de genoemde deelresultaten verder kan worden aangevuld en ben akkoord met het verleende uitstel. Wel maak ik pro forma bezwaar tegen de in uw brief vervatte aantijgingen terzake van incorrecte informatie, met bewaring van rechten. In een naar aanleiding van uw schrijven gevoerd gesprek met uw collegae [redacted] en [redacted], ten kantore van RVO op 5 juli j.l., is door hen aangegeven dat uw brief niet als een beschikking beschouwd diende te worden, doch als een mededeling. Anders zou immers de brief besloten zijn met de mededeling dat hiertegen bezwaar open staat. In het zelfde gesprek is overigens onzerzijds reeds aanvullend bewijs aangevoerd terzake van beide aantijgingen.

Ten aanzien van de vermeende onduidelijkheid over de lokatiekeuze is verwezen naar een eerder gesprek met [redacted], waarin de locatie van de nieuwe lodge ten opzichte van de voormalige partner exact is aangegeven op een zgn 'stafkaart', gevolgd door een email aan RVO verzonden op 19 mei 2015, waarin beide lokaties ten opzichte van elkaar nog nader zijn aangeduid, waarop van uw kant een schriftelijk akkoord op de voorgestelde lokatiewijziging is gevolgd.
Ten aanzien van de projectwijzigingen in het aantal electrisch aangedreven game drive vehicles (eLandy's), waarbij RVO eerder reeds schriftelijk akkoord had gegeven op de vervanging van een eLandy door een eBoat, is in een schrijven d.d. 4 februari 2016 (RMCC rapport ingediend bij RVO) expliciet vermeld dat de leverancier van deze auto's niet langer in staat was deze te leveren, op grond waarvan een projectchange is voorgesteld inzake de vervanging van deze laatste auto door vier schone diesels. Dit is tevens nader toegelicht aan [redacted], tijdens een site bezoek in juni 2016, waar zij meedeelde in overweging te zullen nemen of de ontbrekende eLandy zou kunnen worden gecompenseerd door aantoonbare additionele investeringen in innovatieve/duurzame technologie, waarover in het final report ook is gerapporteerd.

Ten aanzien van het issue terzake van vermeende marktverstoring constateer ik voorts het volgende:
a. Dat ondanks herhaald verzoek onzerzijds nimmer inzage is verstrekt in de door de voormalige partner ingediende klacht
b. Dat naar aanleiding van eerdere informatieverzoeken uwerzijds reeds meerdere keren uitgebreide informatie is verstrekt, waarop nimmer inhoudelijk is gereageerd.

In dit verband is terzake van dit issue in het gesprek op 5 juli j.l. ook door uw collegae aangegeven dat het voor RVO lastig is deze aspecten van de markt daadwerkelijk te doorgronden. Voorts is in dit gesprek aangegeven dat de voormalige partner bij RVO een schadeclaim zou hebben ingediend ad ruim 8 mln euro, voortvloeiende uit de door de subsidieverstrekking vermeend verzoorzaakte marktverstoring. Daarbij is in hetzelfde gesprek aangegeven dat er in beginsel geen reden is tot zorg over daadwerkelijke korting op de eerder toegekende subsidie op grond van deze vermeende marktverstoring, ondanks de harde wijze waarop dit in uw schrijven is verwoord, maar wel dat zeer op prijs gesteld wordt indien eVentures RVO actief kan ondersteunen met nadere gegevens om de gewraakte claim van de voormalige partner te kunnen weerleggen. Tevens werd daarbij onze medewerking verzocht aan een in dit verband door de klager aangespannen WOB procedure, hetgeen door ons is bevestigd.

Voor de goede orde wijs ik u er in dit verband op dat terzake van de eerdere beschikking op grond waarvan de subsidie aanvankelijk is toegekend, ook na de partner change, nimmer afwijkende eisen zijn gesteld ten aanzien van de positionering van de nieuw te realiseren lodge, in termen van de te bereiken doelgroep, tarifiering of anderszins. Op grond van het akkorderen van de partner change en de locatie wijziging en uitvoering van het plan conform de daaraan in de eerdere beschikking gestelde eisen, is daarmee het verwijt van marktverstoring ex post zonder meer onhoudbaar. Voor de goede orde wijs ik u er in dit verband nogmaals op dat de geloofwaardigheid van de voormalige partner terzake van de door hem geuite klacht en daarop volgende schadeclaim uiterst dubieus is, waarover ik u eerder al uitvoerig heb bericht.

Ik ga er vanuit dat na de aanvullende rapportage op de deelresultaten waar naar u in uw schrijven verwijst, welke u in de loop van augustus kunt verwachten, RVO alsnog tot een voorspoedige en faire wijze tot haar eindbeoordeling en vaststelling van de subsidie kan overgaan, inclusief de uitkering van de nog openstaande subsidie tranche, die nu wel heel lang door eVentures is voorgefinancierd.

Met vriendelijke groet,

Vincent Kouwenhoven
eVentures Europe BV

cc. [redacted]

Batch A

Document 3

Netherlands Enterprise Agency

> P.O. box 93144, 2509 AC The Hague, The Netherlands

eVentures Europe BV
Attn. Mr V. Kouwenhoven
Postbus 301
1400 AH BUSSUM

Netherlands Enterprise Agency

Prinses Beatrixlaan 2
2595 AL The Hague
P.O. box 93144
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The Netherlands
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Contact
[redacted]
E psi@rvo.nl

Date 28-07-2017
Regarding Project PSI12/ZM/21

Project title
Green Safaris

Reference number
PSI12ZM21

Our reference
DPSI1707643UU

Enclosure
-

Dear Mr Kouwenhoven,

Per your e-mail of July 16th, 2017 I have received your letter with the title 'Pro forma bezwaar PSI12ZM21'. In this letter you voice your point of view in reaction to my letter dated June 6th, 2017 with questions and remarks concerning your final report. In a meeting on July 5th, 2017 the issues raised in this letter were discussed with you.

Please be informed that the final settlement of the grant will be based on an assessment of the MoV's already provided and on the additional information that will be provided by you.

Should you have any questions, please do not hesitate to contact the PSI secretariat on Tel: +31 (0)88 6028513.

Yours sincerely,

Sanne Zacht
Co-ordinator PSI

This decision was digitally approved in accordance with the mandate published by the Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland) and therefore is not signed.

cc: vincent@eventures.nl

Batch A

Document 4

RVO
T.a.v. [redacted]
Postbus 93144
2509 AC DenHaag

Naarden, 13 september 2017

Betreft: **PSI12ZM21, uw schrijven d.d. 6 juni 2017**

Geachte [redacted],

Hierbij kom ik terug op uw schrijven d.d. 6 juni 2017, waarin u naar aanleiding van de indiening van mijn Final Report inzake bovengenoemd PSI project aangeeft een aantal MOV's af te keuren en uitstel verleent om deze alsnog aan te vullen. Eerder heeft hieromtrent op 5 juli al een gesprek plaatsgevonden met uw collega [redacted], op grond waarvan ik reeds op 14 juli een pro-forma bezwaar tegen uw beslissing van 6 juni j.l. heb ingediend.

In dit schrijven ga ik allereerst in op de vermeende tekortkomingen terzake van de MOV's. Vervolgens adresseer ik uw issues terzake van marktverstoring. Ik heb daarvoor reeds advies ingewonnen bij [redacted], die ik op onderdelen zal citeren. Hij is overigens van mening dat uw verwijt inzake marktverstoring geen enkele houdbare grond kent. Ik ga in dit schrijven niet in op de volstrekt onheuse stellingnames in uw brief dat ik RVO van incorrecte informatie zou hebben voorzien. De bewijsvoering dat deze stellingname volkomen onterecht is geponeerd, heb ik reeds in mijn pro-forma bezwaar op 14 juli aangevoerd.

Sub-result 3.2: "Two additional electric vehicles delivered and transformed".

In de eerste plaats geldt dat ik RVO al in een vroeg stadium heb aangegeven dat levering van de additionele elektrische landrovers op problemen stuitte, op grond waarvan ik toestemming heb gevraagd – en gekregen – om in ieder geval 1 van de elektrische game-drive vehicles te vervangen door een elektrisch aangedreven boot. Voorts is in een schrijven aan RVO op 6 februari 2016 (RMCC rapportage) expliciet vermeld dat de leverancier van de eerste elektrische landrover niet langer in staat was een 2e exemplaar te leveren en dat momenteel nog geen andere leveranciers van dergelijke landrovers bestaan. Dit is voorts nader toegelicht tijdens een site bezoek van [redacted] in juni 2016, waarop zij meedeelde in overweging te zullen nemen of de ontbrekende eLandy zou kunnen worden gecompenseerd door aantoonbare additionele investeringen in innovatieve/duurzame technologie, waarover in het Final Report ook is gerapporteerd. Uw stellingname dat met het ontbreken van 1 van de 3 elektrisch aangedreven voertuigen, het innovatieve karakter van het project ondermijnd zou zijn, bestrijd ik ten zeerste.

De ontwikkeling van de eerste elektrische game-drive vehicle en de inzet van een elektrische boot, hebben enorm de aandacht getrokken binnen de industrie. Er zijn talloze publicaties aan onze innovatie gewijd, onder meer in National Geographic (zie bijlage 1); de lodge heeft de Most Eco Friendly Award van Zambia ontvangen (november 2017), mede door de inzet van onze eLandy en eBoat, en de CO2 reductie waarover u spreekt is aantoonbaar verder teruggebracht door onze additionele initiatieven, waaronder de unieke bouwmethode die door ons is toegepast (sandbag-building), de solar- en biogas-installatie, de ontwikkeling van de Farm en diverse andere compenserende maatregelen.

Het is zeker onze verwachting dat ons initiatief tot de ontwikkeling van de eerste elektrische landrover op termijn navolging gaat krijgen. Het feit dat deze binnen de project-periode nog niet door leveranciers in productie is genomen, doet aan het innovatieve karakter niets af. Het is derhalve overmacht dat deze vervolginvestering nog niet heeft kunnen plaatsvinden. De voor de benodigde capaciteit van de lodge noodzakelijke additionele aanschaf van schone diesels is verder niet als zodanig opgevoerd voor subsidiering. De kosten hiervan zijn uitsluitend opgenomen om transparant te houden in hoeverre onze investering (ver) boven het initieel goedgekeurde budget is uitgekomen. Dus om misverstanden te vermijden bevestig ik nog eenmaal dat de investering in de schone dieselauto's ad. [redacted] niet in het hardwarebudget geclaimd is. Ook na aftrek van deze additionele, niet subsidabele kostenpost, is het totale hardware-budget echter ver uitgestegen boven de oorspronkelijke aanvraag, vanwege de meerkosten op andere wel subsidabele onderdelen (onder meer de Boma constructie op basis van sandbag-building, de aanvullende maatregelen ten aanzien van water-reticulation, de opzet van de Farm, etc.).

Sub-result 5.1 has not been met.
In uw beoordeling van dit sub-result gaat u volledig voorbij aan het feit dat de gepresenteerde cijfers een halfjaars-omzet betreffen, aangezien de lodge eerst op 1 juli 2016 is geopend en de rapportage betrekking heeft op de periode juli-dec 2016. Met andere woorden, u hanteert simpelweg de eerder in de subsidie-aanvraag afgegeven prognose voor de omzet over de eerste 18 maanden, als referentie voor de cijfers van het eerste half jaar. Extrapolatie van deze eerste halfjaar cijfers leert echter dat we dit target zoals oorspronkelijk opgegeven juist hebben overschreden. Immers, opgegeven was een beoogde omzet van [redacted] euro over de eerste 18 maanden, waarbij extrapolatie van het bereikte resultaat over de eerste 6 maanden uit zou komen op [redacted] euro. Het aantal bednachten is maar zeer beperkt achtergebleven op de oorspronkelijke prognose over de eerste 6 maanden ([redacted]. Daarbij geldt dat iedere lodge die nieuw wordt geopend, immer een zekere aanlooptijd vergt, voordat voldoende (naams)bekendheid is gerealiseeerd om tot de gewenste stabiele bezetting te geraken en voorts dat de gehele toeristen-industrie in Zambia sinds het afgelopen seizoen – over de volle breedte – fors in het slop is geraakt. Tegen deze achtergrond zijn wij terecht trots op en tevreden met dit eerder bereikte resultaat. Ook de ontwikkeling van de cijfers over 2017 geeft aan dat we de oorspronkelijk afgegeven targets ruimschoots zullen halen.

Ik begrijp geenszins waarop u uw stellingname baseert dat 'not a single silent safari has been sold'. De lodge besteed in haar marketing juist alle aandacht aan het feit dat wij als enige lodge in Zambia dankzij onze eLandy en eBoat silent safaris kunnen aanbieden, en iedere gast in de lodge wordt ook de mogelijkheid geboden om hiervan gebruik te maken.

Ook in de publiekelijk toegankelijke gasten-reviews (zie Trip-advisor Ila Safari Lodge) wordt bij herhaling explicliet gesproken over de unieke ervaring die gasten hiermee hebben opgedaan. Dit betreft dan ook – anders dan u klaarblijkelijk veronderstelt – geen aparte verkoop-propositie, waarvoor gasten een aparte boeking dienen te maken. Integendeel, al onze gasten worden aangetrokken tot de specifieke positionering en propositie van silent safaris, en zij maken daar dan ook allen tijdens hun verblijf op de lodge gebruik van. Het beloofde aantal ritten is dan ook wel degelijk behaald.

Sub-results 4.1 and 5.3 have not been met.

U stelt terecht dat in de rapportage slechts 56 medewerkers zijn opgenomen, waar wij eerder hadden aangegeven werkgelegenheid te willen bieden aan 59 medewerkers. Wel is ten tijde van de samenstelling van het Final Report nadrukkelijk aangegeven dat we nog steeds verdere groei voorzagen in de bemensing op de Farm. Welnu het verheugt mij u aan te kunnen geven dat het totale aantal medewerkers op de Farm inmiddels is toegenomen tot [redacted] (waar ten tijde van de indiening van het Final Report nog sprake was van een [redacted] medewerkers op de Farm). Hiermee is de totale werkgelegenheid uitgekomen op [redacted] In de bijlage 2 treft u een overzicht van de actuele payroll (juni 2017) van deze [redacted] Farm-medewerkers.

Ten aanzien van de honorering van onze medewerkers is er klaarblijkelijk sprake van een aantal misverstanden. In de eerste plaats refereert u aan de in de aanvraag opgegeven lonen uitgedrukt in USD-equivalenten. De lonen worden evenwel in de lokale munt Kwacha uitbetaald (hetgeen ook wettelijk verplicht is). De Kwacha is in de afgelopen jaren enorm gedevalueerd ten opzichte van de USD (ten tijde van de ingediende aanvraag oorspronkelijk 5:1, thans 10:1), waardoor de lonen thans lager lijken uit te komen. Dat geldt echter zeker niet t.a.v. de koopkracht, aangezien de lonen ten opzichte van binnenlandse producten (waaronder voedsel, huisvesting etc) gelijk zijn gebleven. Nog immer geldt dat onze lonen in Kwacha, met een minimum van [redacted], ver boven het minimum loon in Zambia uitkomen. Het gemiddelde loon van de medium-level employees komt zelfs uit op ruim [redacted], zoals u kunt opmaken uit het eerder toegezonden payroll-overzicht van alle medewerkers. Naast het directe loon, waarbij 'overtime' nadrukkelijk wordt geregistreerd en uitbetaald, ontvangen onze medewerkers op maandbasis nog de volgende extras, die u in uw berekening niet heeft meegenomen:

[redacted]

Ten aanzien van uw kanttekening bij de door ons geboden medische zorg nog het volgende: Wellicht bent u niet bekend met het feit dat in Zambia de medische zorg voor alle inwoners gratis is. De zorg on site wordt door ons kosteloos aangeboden, evenals het vervoer naar een nabij gelegen kliniek, of in ernstiger gevallen, naar een officieel ziekenhuis in Lusaka.

Voor het overige verwijs ik u naar bijlage 3: Onze 'Conditions of Service for employees', die bij iedere arbeidsovereenkomst wordt uitgereikt.

Sub-result 4.2 en 5.4 have not been met or incomplete.

Voor zover het updated Training logbook (MOV 4.2.1) niet afdoende heeft duidelijk gemaakt dat wij al ten tijde van de afronding van het Final Report aanzienlijk meer trainingsdagen hebben verzorgd dan aanvankelijk geprognosticeerd, treft u bijgaand een update van de (ongoing) trainings-activiteiten en daarbij behorende sub-results. In bijlage 4 treft u de volgende aanvullende documenten:

1. Een aanvullende rapportage betreffende de attendance en behaalde modules van de Lobster-Ink training, voor alle employees (incl Health & Safety module)
2. Electric game drive vehicle training, verzorgd door [redacted] aan 8 medewerkers, mei 2016
3. *Systems training (renewable energy and solar systems) aan 8 medewerkers, juni 2016*
4. Aanvullende partner-voorlichting inzake onze eco-setup en systems aan diverse operators, NGO's op 1 juni j.l. (16 attendees)
5. Aanvullende HIV en General Health & Safety update, 3 day workshop, verzorgd door [redacted] (professional nurse) d.d. 21-23 juni 2017 aan 27 medewerkers
6. First Aid training, verzorgd door St John Hospital, 27 juli 2017 aan 17 medewerkers.

Bij deze trainingen aan grotendeels 'illiterate' medewerkers, wordt geen gebruik gemaakt van schriftelijk trainingsmateriaal. Er zijn derhalve geen manuals beschikbaar. Het betreft – evenals bij Lobster-Ink – grotendeels visuele en praktische trainingsessies 'on the job'.

Sub-result 2.3 Completed design and engineering plan for the biogas installation.

In aanvulling op de eerder bij dit sub-result ingediende summary, treft u in bijlage 5 *(seperaat document) het complete design en engineering plan, waaruit blijkt dat het system* volledig is gebaseerd op en gebouwd conform de voorschriften terzake aangaande de international health, safety and environmental regulations. In Zambia is hiervoor geen (externe) keurings-instantie aanwezig, die een en ander ook nog extern kan assesssen en bevestigen.

Sub-result 4.3 Detailed Health and Safety Program insufficient

Het ingediende H&S plan is zorgvuldig samengesteld door de general manager van de lodge, mw Linda van Heerden, en gebaseerd op haar ruime ervaring in de hospitality industry in Afrika. Natuurlijk wordt daarin ook aandacht besteed aan specifieke risico's die minder voor de hand liggen binnen onze specifieke omgeving. Dat neemt niet weg dat er tal van aanvullende procedures bestaan die specifiek toezien op de omstandigheden van onze staff en gasten in onze omgeving. Deze zijn echter niet allemaal geïntegreerd in het voorgelegde overkoepelende H&S plan. Ten aanzien van de keuken-staff is al uitvoerig gewezen op de specifieke procedures en trainingen, zoals geïntegreerd in de Lobster-ink trainings. Ten aanzien van degenen die om gaan met de installaties (solar, eLandy etc) is al gewezen op de specifieke trainingen die zij terzake van de omgang en het onderhoud hiervan hebben gevolgd.

Ten aanzien van de guides en rangers geldt dat zij allen al jarenlang ervaring hebben met het uitoefenen van hun beroep op een veilige wijze, zich bewust zijn van de risico's en ook allen specifieke ranger trainingen hebben gevolgd, waarin zij hebben geleerd en bewezen om te kunnen gaan met de risico's die het werken in de bush aan hen stelt. Uiteraard worden ook onze gasten bij aankomst uitgebreid geïnformeerd over de specifieke H&S issues die van belang zijn bij een verblijf in de bush en participatie aan onze activiteiten. Bijlage 6 bevat een excerpt van deze specifieke informatie die aan hen wordt verstrekt.

Sub-result 5.5 is not assessed as sufficient as the copy of the certificate report has not been submitted.

In bijlage 7 treft u een overzicht van de informatie-uitwisseling met de certificerende organisatie, die heeft geleid tot toekenning van het certificaat.

Market distortion

Ten aanzien van de vermeende marktverstoring geeft u aan dat u reeds in september 2015 een discussie met ons bent gestart, naar aanleiding van een klacht van de voormalige lokale partner. Ondanks herhaald verzoek onzerzijds, heeft u categorisch geweigerd ons inzage te geven in de klacht van deze partner. Ten aanzien van de verschillende informatieverzoeken terzake, hebben wij u immer van de gevraagde informatie voorzien, alsmede uitgebreide inhoudelijke argumentatie, waarop van uw kant echter nimmer enige inhoudelijke reactie is gevolgd, behalve het vragen om meer gedetailleerde informatie. Ook in het Final Report is omstandig ingegaan op de omstandigheden inzake de vermeende marktverstoring, inclusief een uitgebreide toelichting op andere nieuwe toetreders op de markt binnen het zelfde verzorgingsgebied in het Kafue National Park en de specifieke dynamiek rond prijsstelling in deze sector.

In het gesprek naar aanleiding van uw brief met [redacted] op 5 juli j.l. werd voor het eerst melding gemaakt van een claim van de heer van der Heide, van ruim [redacted] euro jegens RVO. In dat zelfde gesprek is ons ook meegedeeld dat het geenszins de bedoeling van RVO was om onze subsidie vergaand te korten of zelfs in te trekken, aangezien er – anders dan de inhoud van uw schrijven d.d. 6 juni doet vermoeden – wel degelijk grote waardering is voor de resultaten die conform de oorspronkelijke doelstellingen van dit project zijn gerealiseerd. Voorts dat gegeven de complexiteit voor RVO om de specifieke dynamiek van de onderhavige sector te doorgronden, wel zeer op prijs gesteld zou worden als wij RVO actief zouden willen ondersteunen in het aandragen van argumenten op grond waarvan de betreffende claim zou kunnen worden gepareerd. Saillant in dit verband is tevens de inhoud van een intern memo van 13 september 2016 van uw medewerker [redacted] dat ons in het kader van de door dhr vd Heide aangespannen WOB procedure heeft bereikt, waarin zij - nog voor sprake is geweest van enig overleg met ons over de vermeende marktverstoring - de optie oppert om de mogelijkheden van terugvordering van de subsidie te onderzoeken.

Hoe het ook zij, bij de beoordeling van onze oorspronkelijke applicatie gold als belangrijk criterium dat onze voorgestelde activiteiten significant vernieuwend moesten zijn. Met deze vernieuwing beoogde PSI om onderontwikkelde economieën te helpen ontwikkelen.

Aanvragen worden afgewezen indien het project niet vernieuwend is en/of leidt tot marktverstoring in de betreffende sector in het project-land. Die beoordeling vindt echter plaats bij de subsidieverlening, niet achteraf! Wij hebben bij de aanvraag uiteengezet waarom er sprake was van een geheel nieuw product: een hoogwaardige eco-lodge, met de inzet van innovatieve technologieën (o.a. elektrische landrovers, sandbag-building, renewable energy) bestond op dat moment nog niet in Zambia en dus ook niet in het Kafue National Park.

De locatie van de lodge wordt door u als wezenlijk beschouwd in de vraag of sprake is van marktverstoring. In dit kader suggereert u in uw brief dat wij u over de gewijzigde locatie niet hebben geïnformeerd. Anders dan u in uw schrijven zeer ten onrechte suggereert is over de locatiekeuze vooraf volstrekte duidelijkheid gegeven, ook ten aanzien van de ligging ten opzichte van Mukambi.

Op het moment van de aanvraag (waar Mukambi nota bene zelf bij betrokken was, en anders dan in het interne memo van [redacted] wordt gesuggereerd, was het niet de applicant die de samenwerking met de lokale partner heeft beëindigd, maar de lokale partner zelf die eenzijdig de samenwerking heeft opgezegd) bestond een dergelijke propositie nog niet. Daarmee heeft de aanvraag destijds dan ook de toets op vernieuwing en marktverstoring doorstaan. Na subsidieverlening is het uitgangspunt dat de subsidie ook overeenkomstig de oorspronkelijke uitgangspunten wordt vastgesteld.

Een ander criterium dat bij de aanvraag getoetst diende te worden, betrof de vraag of de subsidie-verlening tot ongeoorloofde staatssteun zou kunnen leiden. Klaarblijkelijk was hiervan bij uw beoordeling vooraf geen sprake. Zoals uit de financiële verantwoording van het project reeds duidelijk is geworden, zijn de investeringen die met het project gemoeid waren, bijna 1 miljoen hoger uitgepakt dan aanvankelijk begroot. Daarmee is ook het relatieve belang van de subsidie-verlening voor de uiteindelijke exploitatie van de lodge als zodanig verder beperkt en ziet deze vrijwel uitsluitend toe op de vernieuwende, duurzame en hoogwaardige kwaliteitsaspecten van het project, dat zich daarmee onderscheidt van wat er op het moment van de aanvraag reeds beschikbaar was in Zambia. De vraag of Mukambi inmiddels een vergelijkbaar product tegen een vergelijkbare prijs aanbiedt (wat overigens nadrukkelijk wordt betwist), doet er ex post niet toe. Immers, op het moment van de subsidie-toekenning was daarvan in ieder geval nog geen sprake.

Ten aanzien van de discussie over de tarifiering van Ila Safari Lodge versus Mukambi geldt voorts dat bij de oorspronkelijke aanvraag geen eisen zijn gesteld aan onze tarifiering. Het ex post door RVO op leggen van tarief-eisen zou pas leiden tot daadwerkelijke marktverstoring! Het feit dat ons project gesubsidieerd is, kan immers nooit impliceren dat ons prijzen worden gedicteerd die hoger dan marktconform zijn? Ook het feit dat wij ons nadrukkelijk onderscheiden als eco lodge en met een hoogwaardiger kwaliteit dan Mukambi, betekent niet dat onze prijzen per definitie te laag zijn, indien deze zich (somtijds) in de buurt van het door Mukambi gehanteerde prijsniveau begeven. In dat geval zijn de prijzen die Mukambi hanteert klaarblijkelijk en nadrukkelijk te hoog.

Dat de vernieuwing die met het project beoogd werd ook nadrukkelijk door de markt wordt onderkend, blijkt tot slot uit bijlage 8, waarin een beperkte greep uit de klanten-testimonials van operators is opgenomen, die zonder uitzondering de unieke hoogwaardige eco-propositie en de innovativiteit van Ila Safari Lodge in de Kafue benadrukken. In aanvulling op dit schrijven, stuur ik u voorts via WE-Transfer nog een video, waarin de innovatieve, duurzame en eco-aspecten van onze lodge centraal staan, in de hoop dat deze u inspireert bij het maken van uw finale afweging bij de beoordeling van onze resultaten.

Voor het overige verwijs ik nogmaals naar de aangeleverde argumentatie op dit punt in onze eerdere brieven en in ons Final Report.

Tot besluit,

Uw brief van 6 juni j.l. heeft – naast de terechte vragen om aanvullende informatie op sommige van de MOV's – de indruk gewekt dat deze bovenal was ingegeven door de wens om het onderhavige project waar mogelijk op uiteenlopende gronden af te keuren, dan wel een voorschot te willen nemen op een korting op de aanvankelijk toegezegde subsidie. Deze indruk is verstrekt door ons inzage in het interne memo van [redacted] d.d. 13 september 2016, waarin zij nadrukkelijk aangeeft – nav de klacht van dhr van der Heide – te willen zoeken naar mogelijkheden om onze subsidie ex post af te keuren. Ook de toonzetting van uw eerdere correspondentie met een fixatie op vermeende marktverstoring, zonder ons inzage te geven in de klacht – gevolgd door een enorme schade-eis van de kant van de voormalige lokale partner – heeft dit beeld bevestigd. Dit in schrille tegenstelling tot het enthousiasme van uw medewerker [redacted] bij het zien van de door ons bereikte resultaten, kort voor de feitelijke opening van de lodge.

Eerder wees ik u erop dat ik van RVO had verwacht dat zij zich in dit project vanaf het begin tot aan het einde als een ware partner zou opstellen. Ik constateer dat daarvan in de slotfase van dit project ogenschijnlijk minder sprake is geweest. Ik betreur dat ten zeerste. Ik heb als *applicant/ondernemer enorme risico's genomen bij het opzetten van een uniek project*, gericht op de realisatie van de meest duurzame lodge van Zambia, mogelijk zelfs van Afrika. Alom worden wij geprezen om de hoogwaardige kwaliteit, de innovatieve concepten en toegepaste technologie en de daardoor gecreëerde duurzame werkgelegenheid, tegen veel betere condities dan te doen gebruikelijk in Zambia. Dit heeft inmiddels ook geresulteerd in de belangstelling van externe investeerders, om met ons nieuwe lodges te gaan ontwikkelen, in Zambia, maar ook daar buiten (o.a. Malawi en Rwanda), naar het voorbeeld *dat met Ila Safari Lodge is neergezet. Voor de voortgang van deze plannen is duidelijkheid* over de afwikkeling van het onderhavige project een eerste vereiste.

In het gesprek met [redacted] op 5 juli j.l. is ook onderkend dat we een prachtig resultaat hebben neergezet, en dat ik me eigenlijk helemaal niet zoveel zorgen hoef te maken over de afwikkeling van de subsidie. Ik stel op prijs als u bij de finale beoordeling op grond van de in deze brief vervatte informatie, nu dan ook bereid bent om onomwonden *over te gaan tot finale goedkeuring, inclusief acceptatie van de forse extra investeringen in* groene en duurzame technologie, ter compensatie van die ene (vooralsnog) ontbrekende elektrische landrover, alsmede de ter beschikking stelling van de laatste resterende tranche van deze subsidie, die nu inmiddels al een jaar na de oplevering van het project open staat.

Met vriendelijke groet

[redacted]

Vincent Kouwenhoven
eVentures Europe BV

Batch A

Document 4.1

Ila Safari Lodge

ZAMBIA

Opened in June 2016, Ila Safari Lodge is a truly unique eco-lodge, beautifully situated on the banks of the Kafue River. It lies just 170 miles from the Zambian capital, Lusaka, in an area of abundant wildlife.

Established in 1924, Kafue National Park is the second largest in Africa, covering an area of 8,650sq miles. The pristine wilderness is home to approximately 55 different species, including four of the Big Five (leopard, lion, elephant and buffalo), plus the incredibly rare wild dog and the elusive cheetah. The peace and solitude in the Kafue is tangible – other vehicles are a rare sighting in this sparsely populated park.

Ila is the first of its kind in Zambia, boasting an electric game drive vehicle (eLandy) as well as an eBoat, which allows guests to silently experience the bush in an unobtrusive and eco-friendly manner. The lodge is off-grid, with power supplied by a state-of-the-art solar system, and waste is recycled through an ingenious biogas plant.

Guests can bask in the sunshine on Ila Safari Lodge's eBoat while watching a spectacular sunset, or experience a silent safari through the majestic Kafue National Park, soaking up the sights and sounds of the flora and fauna in their natural, undisturbed state. The lodge offers game drives, boat cruises, walking safaris, fishing and several community-based activities, all accompanied by expert guides.

A visit to Ila can also be combined with a trip to Livingstone to see the spectacular Victoria Falls, one of the Seven Natural Wonders of the World.

Ila's main lodge boasts a stunning infinity pool and an open-air restaurant, bar and lounge looking out over the Kafue River. There's also a firepit that's perfect for after-dinner gatherings beneath a canopy of twinkling stars.

Luxury tents are arranged along the riverbank, offering guests an exquisite view of the Kafue and the wildlife that calls it home. Each is furnished in a contemporary African chic style and comes complete with an en suite bathroom featuring either a bath or shower on the outdoor deck. There are two family tents and children of all ages are warmly welcomed.

NEED TO KNOW

KEY FACILITIES

- All tents are on the edge of the Kafue River, overlooking the national park
- Six tents have outside showers and either twin or king beds
- Two luxury tents boast indoor shower and outdoor baths
- Two luxury family tents feature an indoor shower and bath
- Age restrictions for children on certain activities apply

KEY ACTIVITIES

- Game drives
- Boat cruises
- Fishing trips
- Walking safaris
- Community Outings

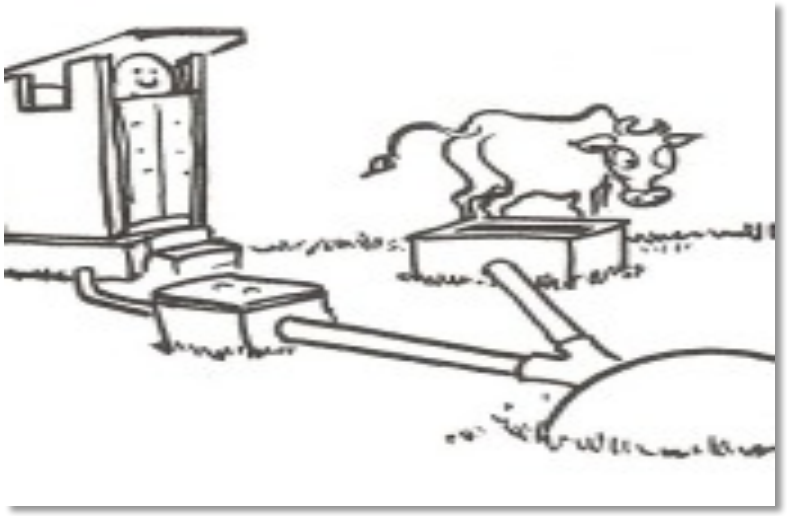
GET IN TOUCH

greensafaris.com
T: +260 976 366 054
E: welcome@greensafaris.com

Don't miss // Board the eBoat or enjoy a drive on the eLandy for a totally silent safari experience in Africa's second-biggest national park

Batch A

Document 4.5



Digester Design and Implementation Information for

Green Safaris Zambia

Digesters can be designed for batch-feeding or for continuous feeding. With batch digesters a full charge of raw material is placed into the digester which is then sealed off and left to ferment as long as gas is produced. When gas production has ceased, the digester is emptied and refilled with a new batch of raw materials. Batch digesters have advantages where the availability of raw materials is sporadic or limited to coarse plant wastes (which contain undigestible materials that can be conveniently removed when batch digesters are reloaded). Also, batch digesters require little daily attention. Batch digesters have disadvantages, however, in that a great deal of energy is required to empty and load them; also gas and sludge production tend to be quite sporadic. You can get around this problem by constructing multiple batch digesters connected to the same gas storage. In this way individual digesters can be refilled in staggered sequence to ensure a relatively constant supply of gas. Most early digesters were of the batch type. With continuous-load digesters, a small quantity of raw material is added to the digester every day or so. In this way the rate of production of both gas and sludge is more or less continuous and reliable. Continuous-load digesters are especially efficient when raw materials consist of a regular supply of easily digestible wastes from nearby sources such as livestock manures, seaweed, river or lake flotsam or algae from production sludge-ponds. The first continuous-load digester seems to have been built in India by Patel in 1950 (Ref. 43). Continuous-feeding digesters can be of two basic designs: vertical-mixing or displacement (Fig. 13). Vertical-mixing digesters consist of vertical chambers into which raw materials are added. The slurry rises through the digester and overflows at the top. In single-chamber designs the digested or "spent" slurry can be withdrawn directly from effluent pipes. In double-chamber designs the spent slurry, as it overflows the top, flows into a second chamber where digestion continues to a greater degree of completion.

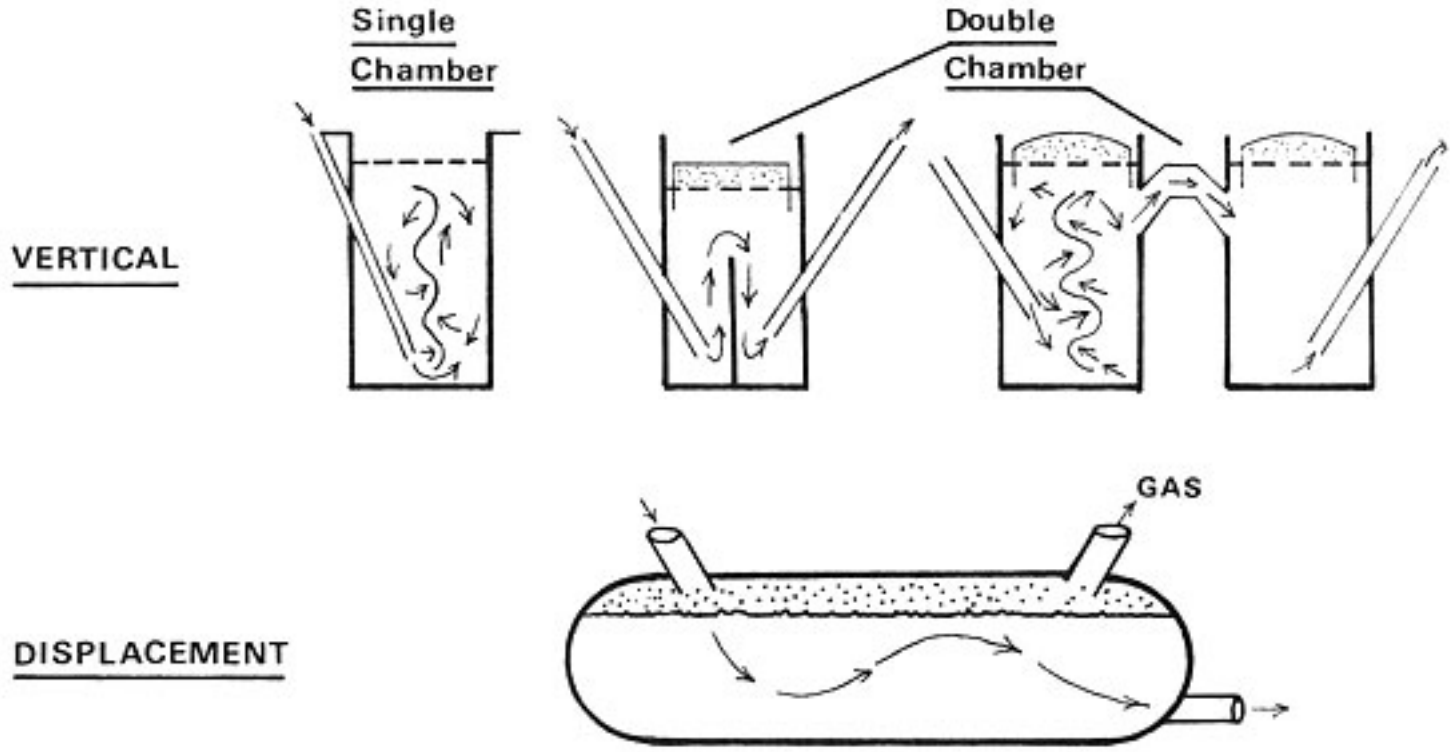


FIG.13 Types of Continuous-Feeding Digesters

Displacement digesters consist of a long cylinder lying parallel to the ground (e.g., inner tubes, oil drums welded end on end, tank cars, etc.). As it is digested the slurry is gradually *displaced* toward the opposite end, passing a point of maximum fermentation on the way. The displacement digester design seems to have distinct advantages over vertical-mixing designs popularized in India:

1. In vertical-mixing digesters raw material is subject to a vertical pumping motion and often escapes the localized action of digesting bacteria. Slurry introduced at one time can easily be withdrawn soon afterwards as incompletely digested material. In displacement digesters slurry must pass an area of maximum fermentation activity so that all raw materials are effectively digested (much like the intestines of an animal).
2. From a practical point of view, displacement digesters are easier to operate. If digester contents begin to sour for one reason or another, strongly buffered material at the far end can be recirculated efficiently by simply reversing the flow of material along the line of the cylinder. In addition, raw materials can be digested to any desired degree without the need for constructing additional chambers or digesters.
3. The problem of scum accumulation is reduced in displacement digesters. Since scum forms evenly on the surface of the digesting slurry, the larger the surface area, the longer it takes to accumulate to the point where it inhibits digestion. A prone cylinder has a larger surface area than an upright one.
4. Any continuous-load digester will eventually accumulate enough scum and undigested solid particles so that it will have to be cleaned. The periodical washing out of displacement digesters is considerably easier than vertical-mixing digesters.

The first large-scale displacement digester was designed and built by L. John Fry during the late 1950's on his pig farm in South Africa (Ref. 42, 44). Mr. Fry, now a resident of Santa Barbara, is acting consultant for the New Alchemy digester project which is currently focusing attention on the design and utilization of small-scale displacement digesters.

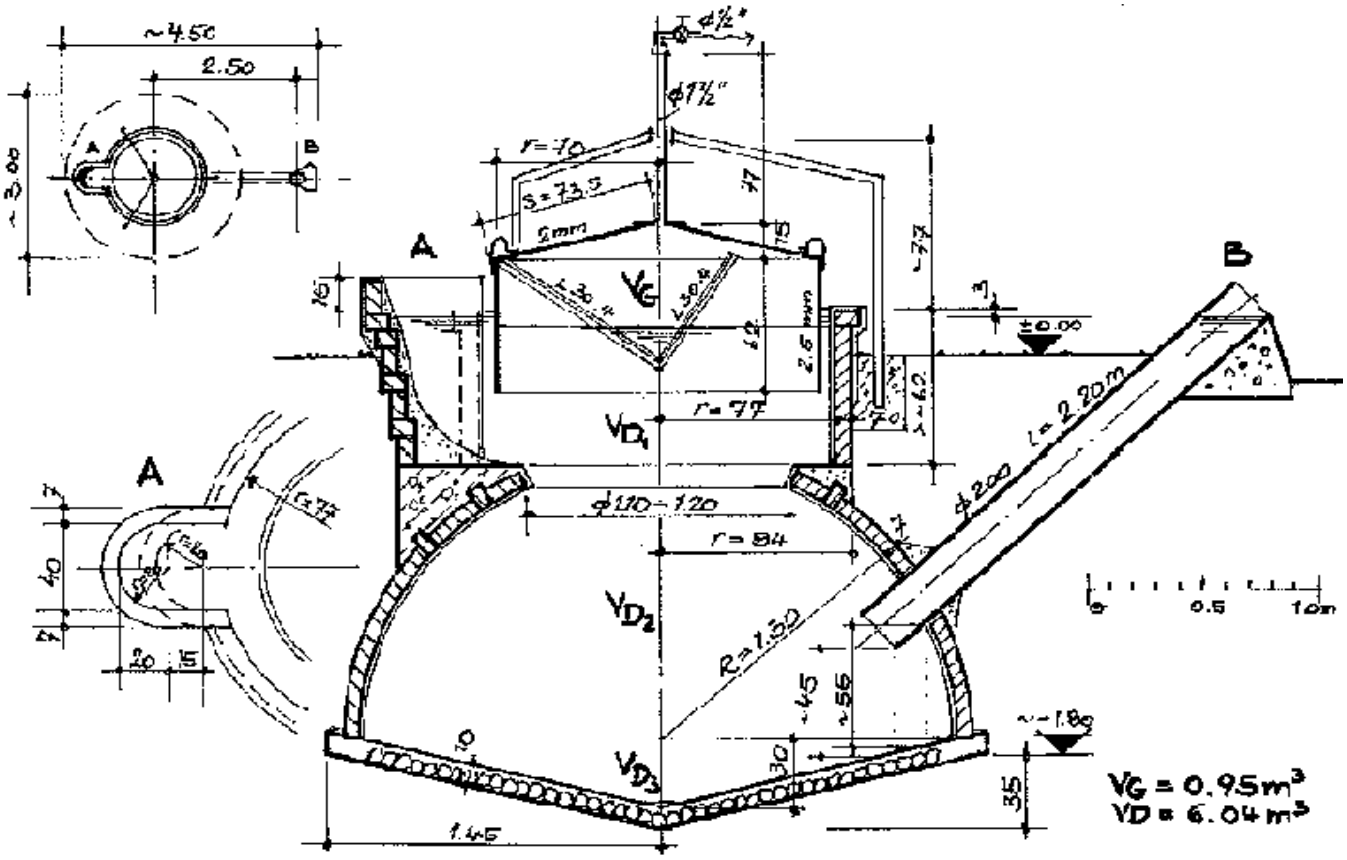
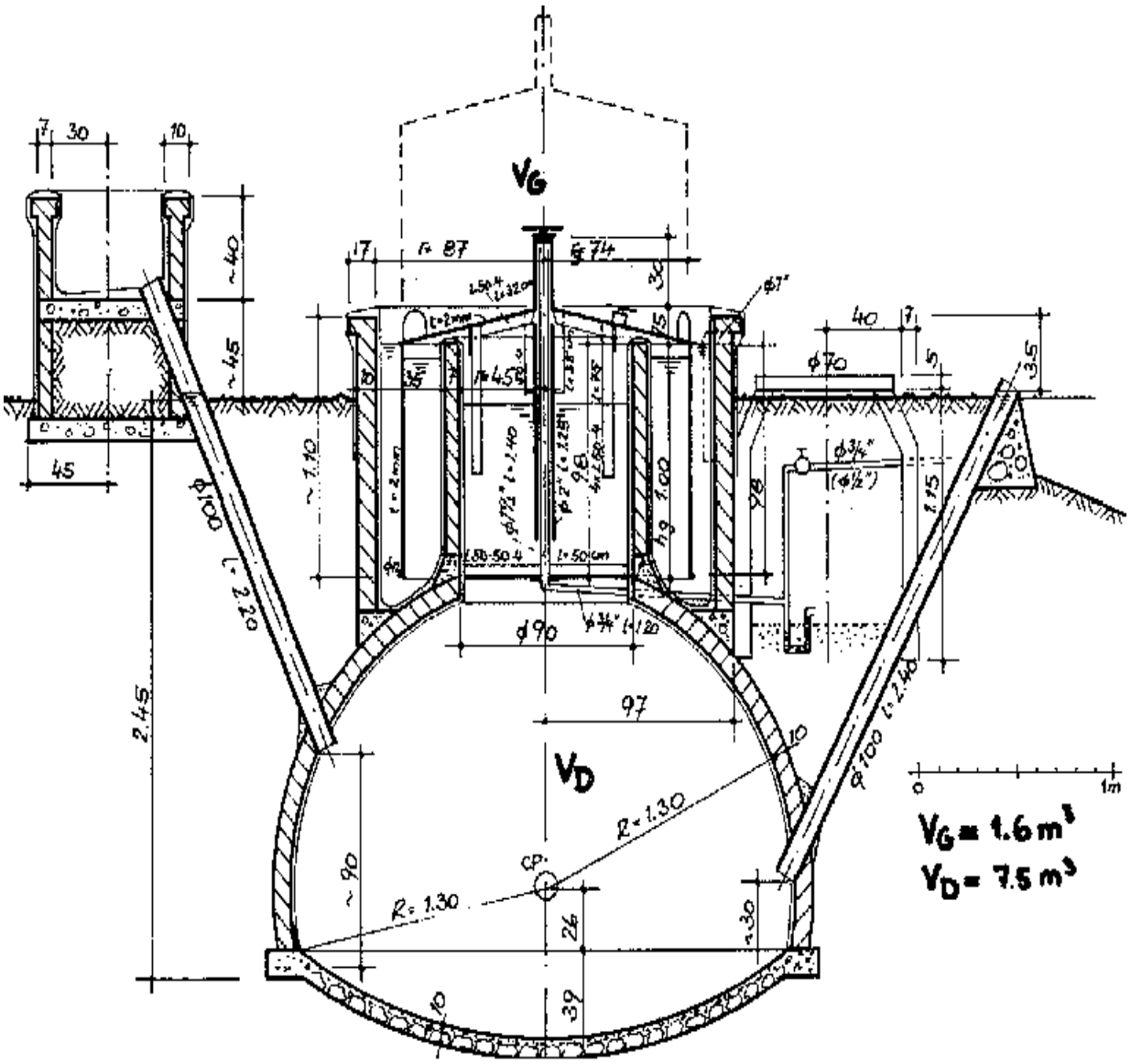

~4.50
2.50
~3.00
A
B
ϕ½"
ϕ1½"
r=70
s=73.5
2mm
15
~73
A
B
10
VG
30°
12
2.6 mm
3
±0.00
r=77
~62
VD1
ϕ110-120
r=84
ϕ200
L=2.20m
VD2
R=1.50
45
~56
~1.80
30
35
VD3
1.45
0
0.5
1m
VG = 0.95m³
VD = 6.04 m³

Fig. 46: Calculation of dimensions
Floating-drum plant with water jacket



5.5.2
Conditioning of biogas

While the biogas produced by the plant can normally be used as it is, i.e. without further treatment/conditioning, various conditioning processes are described in this chapter to cover possible eventualities.

Reducing the moisture content of the biogas, which is usually fully saturated with water vapor. This involves cooling the gas, e.g. by routing it through an underground pipe, so that the excess water vapor condenses out at the lower temperature. When the gas warms up again, its relative vapor content decreases (cf. chapter 10.2 for calculations). The "drying" of biogas is especially useful in connection with the use of dry gas meters, which otherwise would eventually fill up with condensed water. **Table 5.14: Composition and properties of biogas, and its constituents under s.t.p. conditions (0 °C, 1013 mbar) (Source: OEKOTOP, compiled from various sources)**

Constituents and properties	**CH4**	**CO2**	**H2**	**H2S**	**60% CH4/ 40% CO2**	**65% CH4/ 34% C02/ 1% rest**
Volume fraction (%)	55-70	27-44	1	3	100	100
Net calorific value (kWh/m³)	9.9	-	3.0	6.3	6.0	6.8
Ignition threshold (% in air)	5-1S	-	4-80	4-45	6-12	7.7 – 23
Ignition temperature (°C)	650-750	-	585	-	650-750	650-750
Crit.pressure (bar)	47	75	13	89	75-89	75-89
Crit. temp. (°C)	-82.5	31.0	-240	100.0	-82.5	-82.5
Normal density (g/1)	0.72	1.98	0.09	1.54	1.2	1.15
Gas/air-density ratio	0.55	2.5	0.07	1.2	0.83	0.91
Wobbe index, K (kWh/m³)	13.4	-	-	-	6.59	7.15
Spec. heat, cp (kI/m³ °C)	1.6	1.6	1.3	1.4	1.6	1.6
Flame propagation (cm/s)	43	-	47	-	36	38

Reduction of the hydrogen-sulfide content (H_2S) may be necessary if the biogas is found to contain an excessive amount, i.e. more than 2%, and is to be used for fueling an engine. Since, however, most biogas contains less than 1% H_2S, desulfurization is normally unnecessary, especially if it is to be used for operating a stationary engine.

For small-to-midsize systems, desulfurization can be effected by absorption onto ferric hydrate (Fe (OEI)3), also referred to as bog iron, a porous form of limonite. The porous, granular purifying mass can be regenerated by exposure to air.

The absorptive capacity of the purifying mass depends on its iron-hydrate content: bog iron containing 5-10% $Fe(OH)_3$ can absorb about 15 g sulfur per kg without being regenerated and approximately 150 g/ kg through repetitive regeneration. It is a very noteworthy fact that many types of tropical soil (laterites) are naturally ferriferous and, hence, suitable for use as purifying mass.

Reduction of the carbon-dioxide content (CO_2) is very complicated and expensive.

In principle, CO_2 can be removed by absorption onto lime milk, but that practice produces "seas" of lime paste and must therefore be ruled out, particularly in connection with large-scale plants, for which only high-tech processes like microscreening are worthy of consideration. CO_2 "scrubbing" is rarely advisable, except in order to increase the individual bottling capacity for high-pressure storage.

5.5.3 Biogas appliances

Biogas is a lean gas that can, in principle, be used like any other fuel gas for household and industrial purposes, the main prerequisite being the availability of specially designed biogas burners or modified consumer appliances. The relatively large differences in gas quality from different plants, and even from one and the same plant (gas pressure, temperature, calorific value, etc.) must be given due consideration.

The heart of any gas appliance is the burner. In most cases, atmospheric-type burners operating on premixed air/gas fuel are considered preferable.

Due to complex conditions of flow and reaction kinetics, gas burners defy precise calculation, so that the final design and adjustments must be arrived at experimentally.

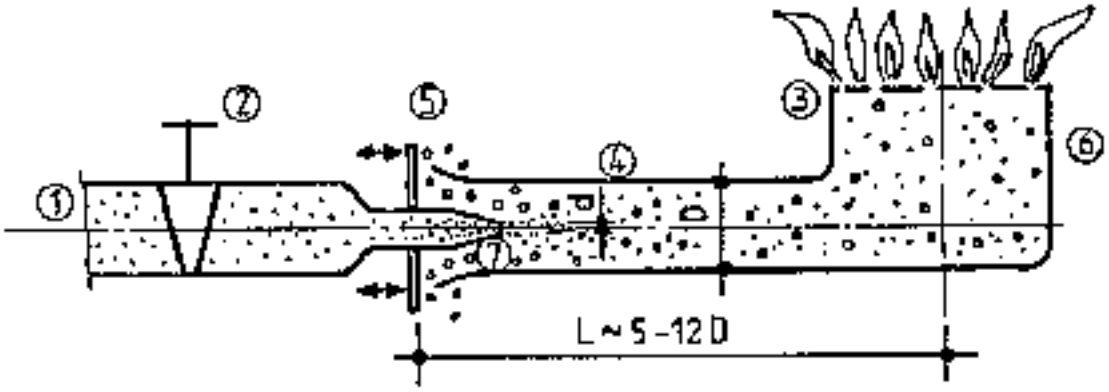


Fig. 5.30: Schematic drawing of a biogas burner and its parts. 1 Gas pipe, 2 Gas-flow shutoff/reducing valve, 3 Jets (f = 1-2 mm), 4 Mixing chamber for gas and combustion air, 5 Combustion air intake control, 6 Burner head, 7 Injector (Source: Sasse 1984)

Accordingly, the modification and adaptation of commercial-type burners is an experimental matter. With regard to butane and propane burners, i.e. the most readily available types, the following pointers are offered:
- Butane/propane gas has up to 3 times the calorific value of biogas and almost twice its flame-propagation rate.
- Conversion to biogas always results in lower performance values.
Practical modification measures include:
- expanding the injector cross section by a factor of 2-4 in order to increase the flow of gas
- modifying the combustion-air supply, particularly if a combustion-air controller is provided - increasing the size of the jet openings (avoid if possible) The aim of all such measures is to obtain a stable, compact, slightly bluish flame.

5.5.4 Biogas-fueled engines

Basic considerations

The following types of engines are, in principle, well-suited for operating on biogas:

- Four-stroke diesel engines: A diesel engine draws in air and compresses it at a ratio of 17: 1 under a pressure of approximately 30-40 bar and a temperature of about 700 °C. The injected fuel charge ignites itself. Power output is controlled by varying the injected amount of fuel, i.e. the air intake remains constant (so-called mixture control).

- Four-stroke spark-ignition engines: A spark-ignition engine (gasoline engine) draws in a mixture of fuel (gasoline or gas) and the required amount of combustion air. The charge is ignited by a spark plug at a comparably low compression ratio of between 8: 1 and 12: 1. Power control is effected by varying the mixture intake via a throttle (so-called charge control).

Four-stroke diesel and spark-ignition engines are available in standard versions with power ratings ranging from 1 kW to more than 100 kW. Less suitable for biogas fueling are:

- loop-scavenging 2-stroke engines in which lubrication is achieved by adding oil to the liquid fuel, and

- large, slow-running (less than 1000 r.p.m.) engines that are not built in large series, since they are accordingly expensive and require complicated control equipment.

Biogas engines are generally suitable for powering vehicles like tractors and light-duty trucks (pickups, vans). The fuel is contained in 200-bar steel cylinders (e.g. welding-gas cylinders). The technical, safety, instrumentational and energetic cost of gas compression, storage and filing is substantial enough to hinder large-scale application. Consequently, only stationary engines are discussed below.

Essential terms and definitions

Knowledge of the following terms pertaining to internal combustion engines is requisite to understanding the context:

Piston displacement is the volume (cm^3, l) displaced by a piston in a cylinder in a single stroke, i.e. between the bottom and . top dead-canter positions (BDC and TDC, respectively). The total cylinder capacity (Vtot) comprises the swept volume (Vs) and the compression volume (Vc), i.e. Vtot = Vs+Vc.

The compression ratio (E) is the ratio of the maximum to the minimum volume of the space enclosed by the piston, i.e. prior to compression (Vtot) as compared to the end of the compression stroke (Vc). The compression ratio can be used to calculate the pressure and temperature of the compressed fuel mixture (E = Vtot/Vc).

The efficiency (rl = Pc/Pf) is the ratio between the power applied to the crankshaft (Pc) and the amount of energy introduced with the fuel (Pf = V x n.c.v.).

Ignition and combustion: The firing point (diesel: flash point; spark-ignition engine: ignition point) is timed to ensure that the peak pressure is reached just after the piston passes top dead center (approx. 10° - 15° crankshaft angle). Any deviation from the optimal fiash/ignition point leads to a loss of power and efficiency; in extreme cases, the engine may even suffer damage. The flash/ignition point is chosen on the basis of the time history of combustion, i.e. the rate of combustion, and depends on the compression pressure, type of fuel, combustion-air/ fuel ratio and the engine speed. The ignition timing (combustion) must be such that the air/fuel mixture is fully combusted at the end of the combustion cycle, i.e. when the exhaust valve opens, since part of the fuel's energy content would otherwise be wasted.

Air/Fuel-ratio and control: Proper combustion requires a fuel-dependent stoichiometric air/fuel-ratio (af-ratio). As a rule, the quality of combustion is maximized by increasing the air fraction, as expressed by the air-ratio coefficient (d = actual air volume/stoichiometric air volume).

Converting diesel engines

Diesel engines are designed for continuous operation (10 000 or more operating hours). Basically, they are well-suited for conversion to biogas according to either of two methods:

The dual-fuel approach

Except for the addition of a gas/air mixing chamber on the intake manifold (if need be, the air filter can be used as a mixing chamber), the diesel engine remains extensively unmodified. The injected diesel fuel still ignites itself, while the amount injected is automatically reduced by the speed governor, depending on how much biogas is introduced into the mixing chamber. The biogas supply is controlled by hand. The maximum biogas intake must be kept below the point at which the engine would begin to stutter. If that happens, the governor is getting too much biogas and has therefore turned down the diesel intake so far that ignition is no longer steady. Normally, 15 - 20% diesel is sufficiency, meaning that as much as 80% of the diesel fuel can be replaced by biogas. Any lower share of biogas can also be used, of course, since the governer automatically compensates with more diesel.

As a rule, dual-fuel diesels perform just as well as a comparable engine operating on pure diesel.

As in normal diesel operation, the speed is controlled by an accelerator lever, and load control is normally effected by hand, i.e. by adjusting the biogas valve (keeping in mind the maximum acceptable biogas intake level). In case of frequent power changes joined with steady speed, the biogas fraction should be reduced somewhat to let the governer decrease the diesel intake without transgressing the minimum amount. Thus, the speed is kept constant, even in case of power cycling. Important: No diesel engine should be subjected to air-side control.

While special T-pieces or mixing chambers with 0.5 to 1.0 times the engine displacement can serve as the diesel/biogas mixing chamber, at which a true mixing chamber offers the advantage of more thorough mixing.

Conversion according to the dual-fuel method is evaluated as follows

- a quick & easy do-it-yourself technique - will accommodate an unsteady supply of biogas - well-suited for steady operation, since a single manual adjustment will suffice - requires a minimum share of diesel to ensure ignition.

Conversion to spark ignition (Otto cycle)

involves the following permanent alterations to the engine:

- removing the fuel-injection pump and nozzle - adding an ignition distributor and an ignition coil with power supply (battery or dynamo) - installing spark plugs in place of the injection nozzles - adding a gas mixing valve or carburetor - adding a throttle control device - reducing the compression ratio to E = 11-12 - observing the fact that, as a rule, engines with a precombustion or swirl chamber are not suitable for such conversion.

Converting a diesel engine to a biogas-fueled spark-ignition engine is very expensive and complicated - so much so, that only preconverted engines of that type should be procured.

Converting spark-ignition engines

Converting a spark-ignition engine for biogas fueling requires replacement of the gasoline carburetor with a

mixing valve (pressure-controlled venturi type or with throttle). The spark-ignition principle is retained, but should be advanced as necessary to account for slower combustion (approx. 5°-10° crankshaft angle) and to avoid overheating of the exhaust valve while precluding loss of energy due to still-combustible exhaust gases. The engine speed should be limited to 3000 r.p.m. for the same reason. As in the case of diesel-engine conversion, a simple mixing chamber should normally suffice for continuous operation at a steady speed. In addition, however, the mixing chamber should be equipped with a hand-operated air-side control valve for use in adjusting the air/fuel ratio (opt. d = 1.1).

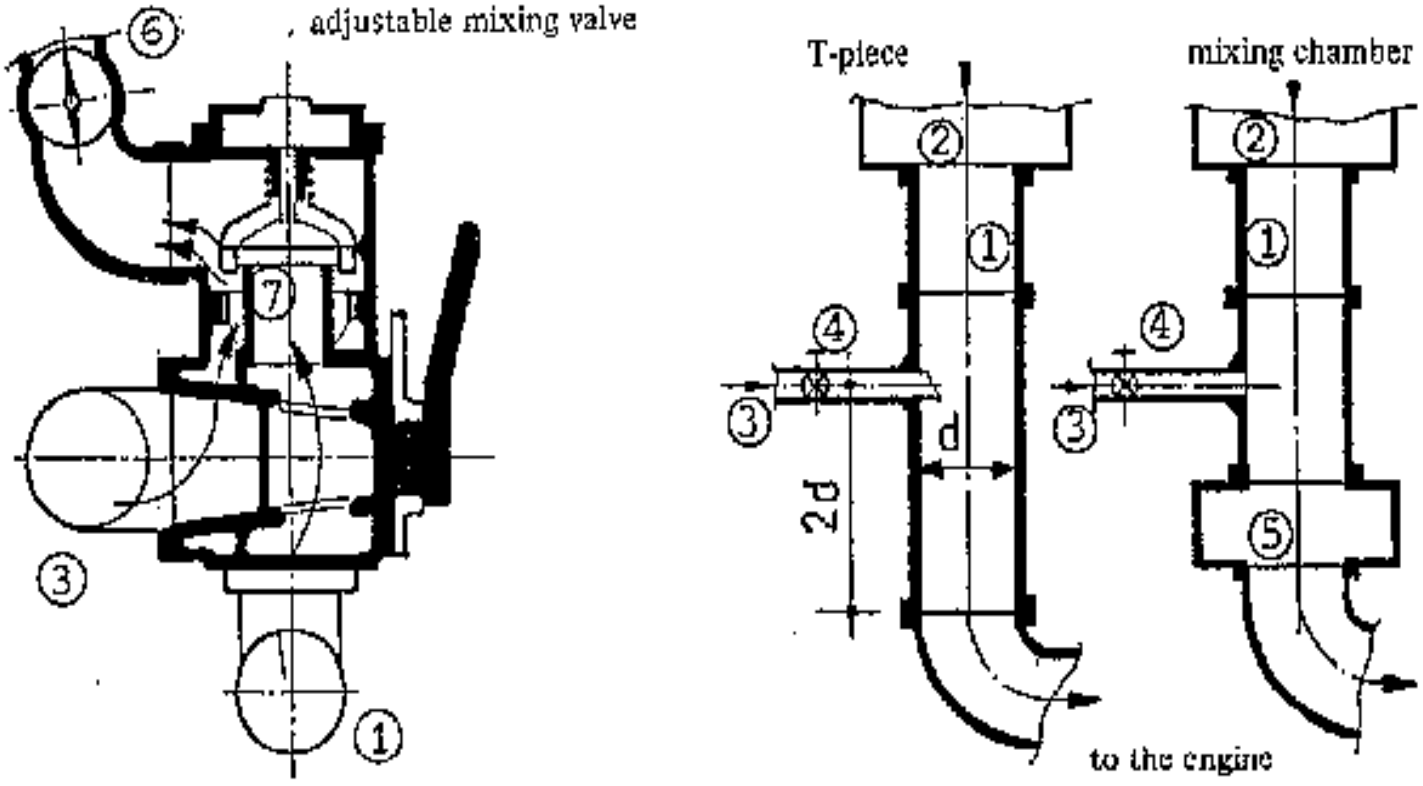


Fig. 5.35: Various gas mixers for spark-ignition and diesel engines. 1 Air intake, 2 Air filter, 3 Biogas supply pipe, 4 Biogas control valve, 5 Mixing chamber (0.5 - 1 X piston displacement) 6 Throttle, 7 Mixing valve (Source: OEKOTOP)

7.2 Plant operation

The operation of a simple biogas plant is relatively uncomplicated. The user must be given all the information and practical assistance he needs before and during the early phases of plant operation.

Collecting substrate

The collection of substrate is a simple matter when combined with work that has to be done anyway, e.g. cleaning the stables. It can be made even easier by arranging for the manure to flow directly into the mixing pit. Experience shows that it is not a good idea to gather dung from fields, roads, etc. or to go to the trouble of elaborately chopping up or otherwise preprocessing plant material for use as substrate. The work involved is usually underestimated, while the motivation is overestimated.

Filling the plant

Filling means: mixing the substrate with water, removing bouyant materials, allowing the fill material to warm up, flushing it into the digester, and removing sand and stones. The simple mixing pit shown in figure 5.16 can handle a daily fill quantity of up to 500 1.

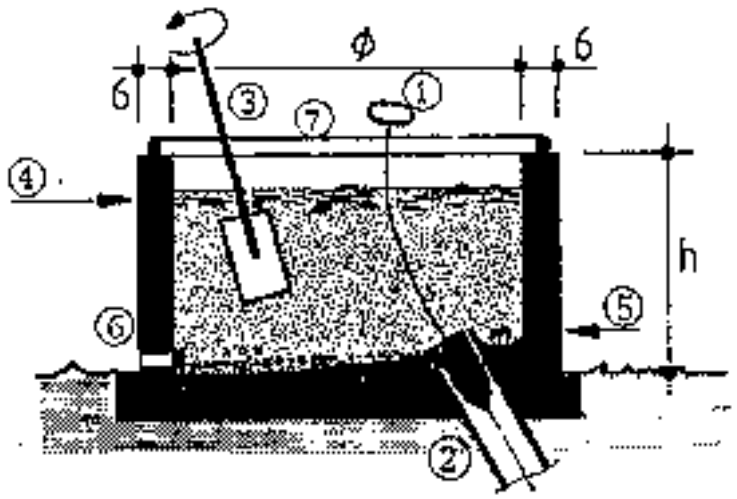


Fig. 5.16: Mixing pit. 1 Plug, 2 Fill pipe, 3 Agitator, 4 Fibrous material, 5 Sand, 6 Drain, 7 Screen cover (Source: OEKOTOP)

5.4.1 Mixing pit

In the mixing pit, the substrate is diluted with water and agitated to yield a homogeneous slurry. The fibrous material is raked off the surface, and any stones or sand settling to the bottom are cleaned out after the slurry is admitted to the digester.

The useful volume of the mixing pit should amount to 1.5-2 times the daily input quantity. A rock or wooden plug can be used to close off the inlet pipe during the mixing process. A sunny location can help warm the contents before they are fed into the digester in order to preclude thermal shock due to the cold mixing

water. In the case of a biogas plant that is directly connected to animal housing, it is advisable to install the mixing pit deep enough to allow installation of a floating gutter leading directly into the pit. Care must also be taken to ensure that the low position of the mixing pit does not result in premature digestion and resultant slurry formation. For reasons of hygiene, toilets should have a direct connection to the inlet pipe.

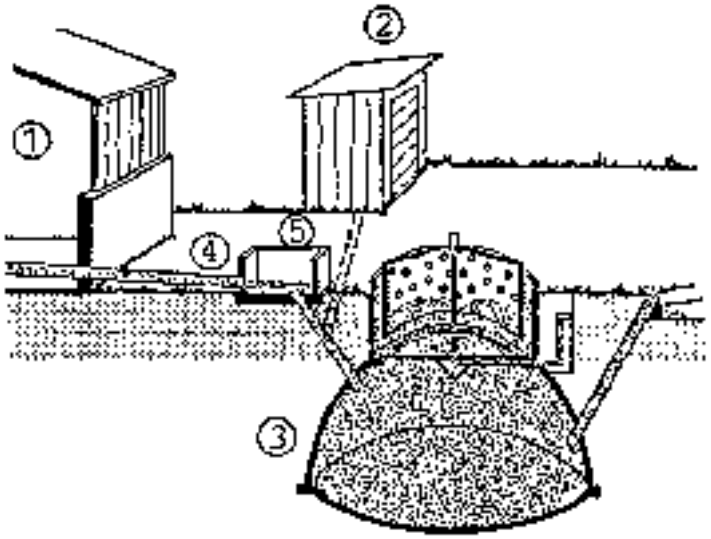


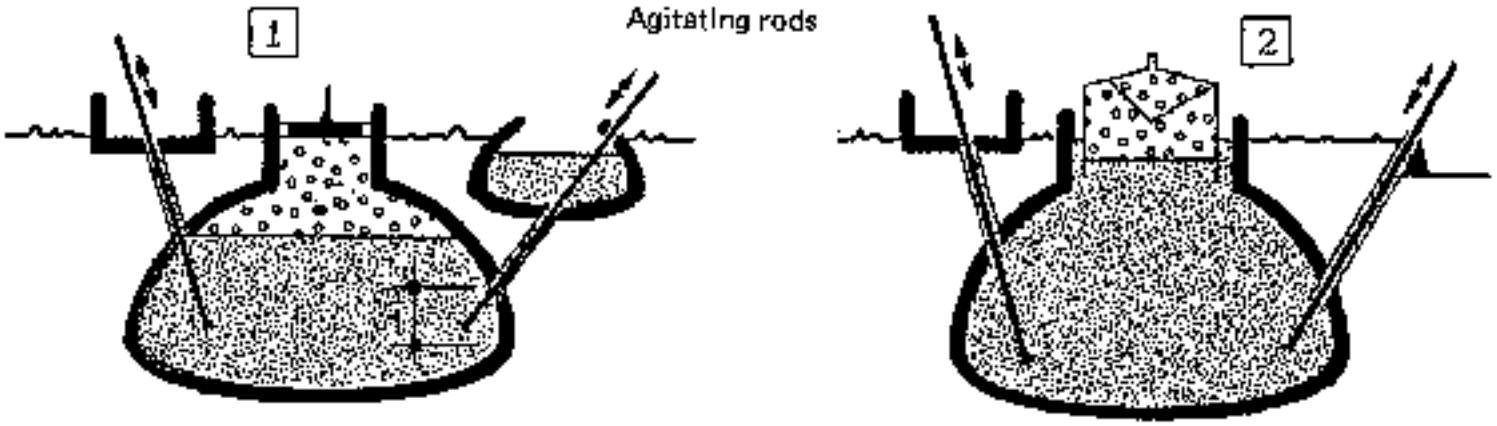
Fig. 5.17: Mixing pit, gutter and toilet drain pipe. 1 Barn, 2 Toilet, 3 Biogas plant, 4 Feed gutter 2% gradient), 5 Mixing pit (Source: OEKOTOP)

5.4.2 Inlet and outlet

The inlet (feed) and outlet (discharge) pipes lead straight into the digester at a steep angle. For liquid substrate, the pipe diameter should be 10-15 cm, while fibrous substrate requires a diameter of 20 - 30 cm. Plastic or concrete pipes are preferred.

Note:

- Both the inlet pipe and the outlet pipe must be freely accessible and straight, so that a rod can be pushed through to eliminate obstructions and agitate the digester contents;
- The pipes should penetrate the digester wall at a point below the slurry level. The points of penetration should be sealed off and reinforced with mortar.
- The inlet pipe ends higher than the outlet pipe in the digester in order to promote more uniform throughflow. In a fixed-dome plant, the inlet pipe defines the bottom limit of the gasholder, thus providing overpressure relief.
- In a floating-drum plant, the end of the outlet pipe determines the digester's slurry level.



In designing the plant, care must be taken to ensure that the slurry store will be large enough. Fixed-dome plants in particular should be equipped with an overflow, so that the digested slurry does not have to be hauled away every day. **Table 7.2: Checklist for the daily operation and regular maintenance of biogas plants (Source: OEKOTOP)**

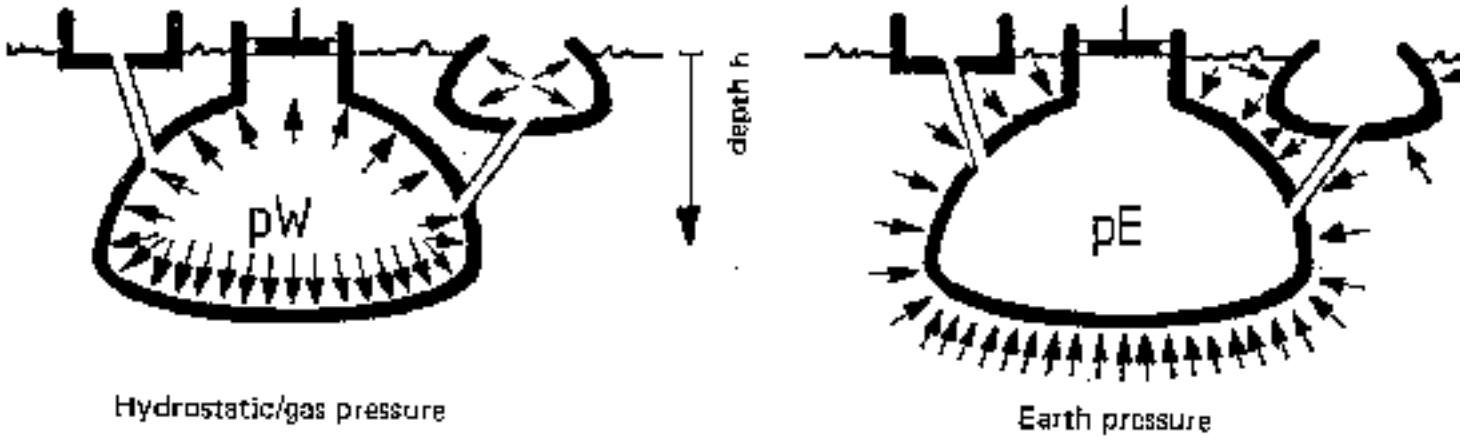


Fig. 5.19: Forces acting on a spherical-dome digester (Source: OEKOTOP)

5.4.3 Digester

Design

The digester of a biogas plant must accommodate the substrate and bacterial activity, as well as fulfill the following structural functions:

- accept the given static forces - provide impermeability to gas and liquids - be durable and resistant to corrosion

As a rule, the digesters of simple biogas plants are made of masonry or concrete. Such materials are adequately pressure-resistant, but also susceptible to cracking as a result of tensile forces.

The following forces act on the digester:

- external active earth pressures (pE), causing compressive forces within the masonry - internal hydrostatic

and gas pressures (pW), causing tensile stress in the masonry.

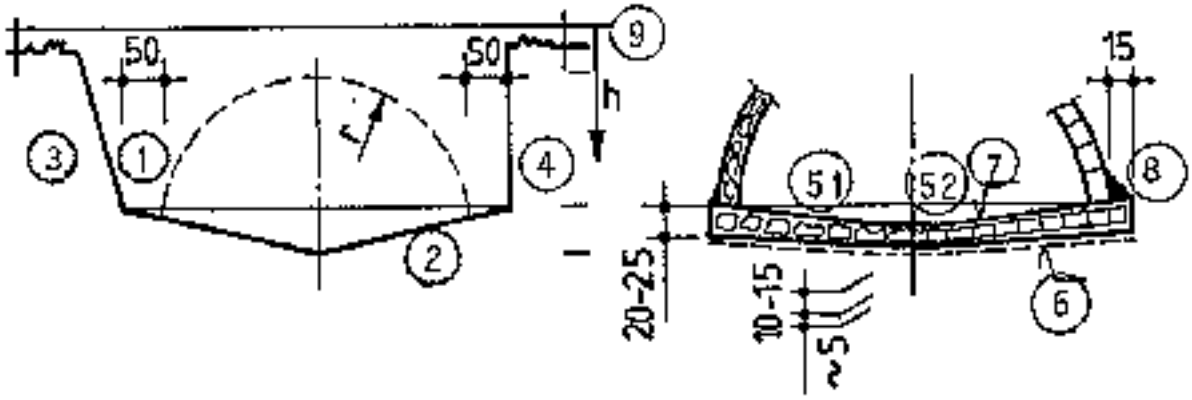


Fig. 5.20: Level line, excavation and foundation. 1 Workspace, 2 Inclination of conical foundation, 3 Sloping excavation, 4 Vertical excavation, 51 Quarrystone foundation, 52 Brick foundation, 6 Packing sand, 7 Mortar screed, 8 Foot reinforcement for fixed-dome plant, 9 Level line (Source: OEKOTOP / Sasse 1984)

Thus, the external pressure applied by the surrounding earth must be greater at all points than the internal forces (pE > pW). For the procedure on how to estimate earth force and hydrostatic forces, please refer to chapter 10.1.4.

Round and spherical shapes are able to accept the highest forces—and do it uniformly. Edges and corners lead to peak stresses and, possibly, to tensile stresses and cracking. Such basic considerations suggest the use of familiar cylindrical and dome designs allowing:

- inexpensive, material-sparing construction based on modest material thicknesses - a good volume/surface ratio and - better (read: safe) stability despite simple construction.

The dome foundation has to contend with the highest loads. Cracks occurring around the foundation can spread out over the entire dome, but are only considered dangerous in the case of fixed-dome plants. A rated break ring can be provided to limit cracking.

Groundwork

The first step of building the plant consists of defining the plant level line with a taut string. All important heights and depths are referred to that line.

Excavation

The pit for the biogas plant is excavated by hand in the shape of a cylindrical shaft. The shaft diameter should be approx. 2 x 50 cm larger than that of the digester. If the soil is adequately compact and adhesive, the shaft wall can be vertical. Otherwise it will have to be inclined. The overburden, if reusable, is stored at the side and used for backfilling and compacting around the finished plant.

Foundation

The foundation slab must be installed on well-smoothed ground that is stable enough to minimize settling. Any muddy or loose subsoil (fill) must be removed and replaced by sand or stones. The bottom must have the shape of a shallow inverted dome to make it more stable and rigid than a flat slab. Quarrystones, bricks and mortar or concrete can be used as construction materials. Steel reinforcing rods are only necessary for large plants, and then only in the form of peripheral ties below the most heavily burdened part, i.e. the dome foundation.

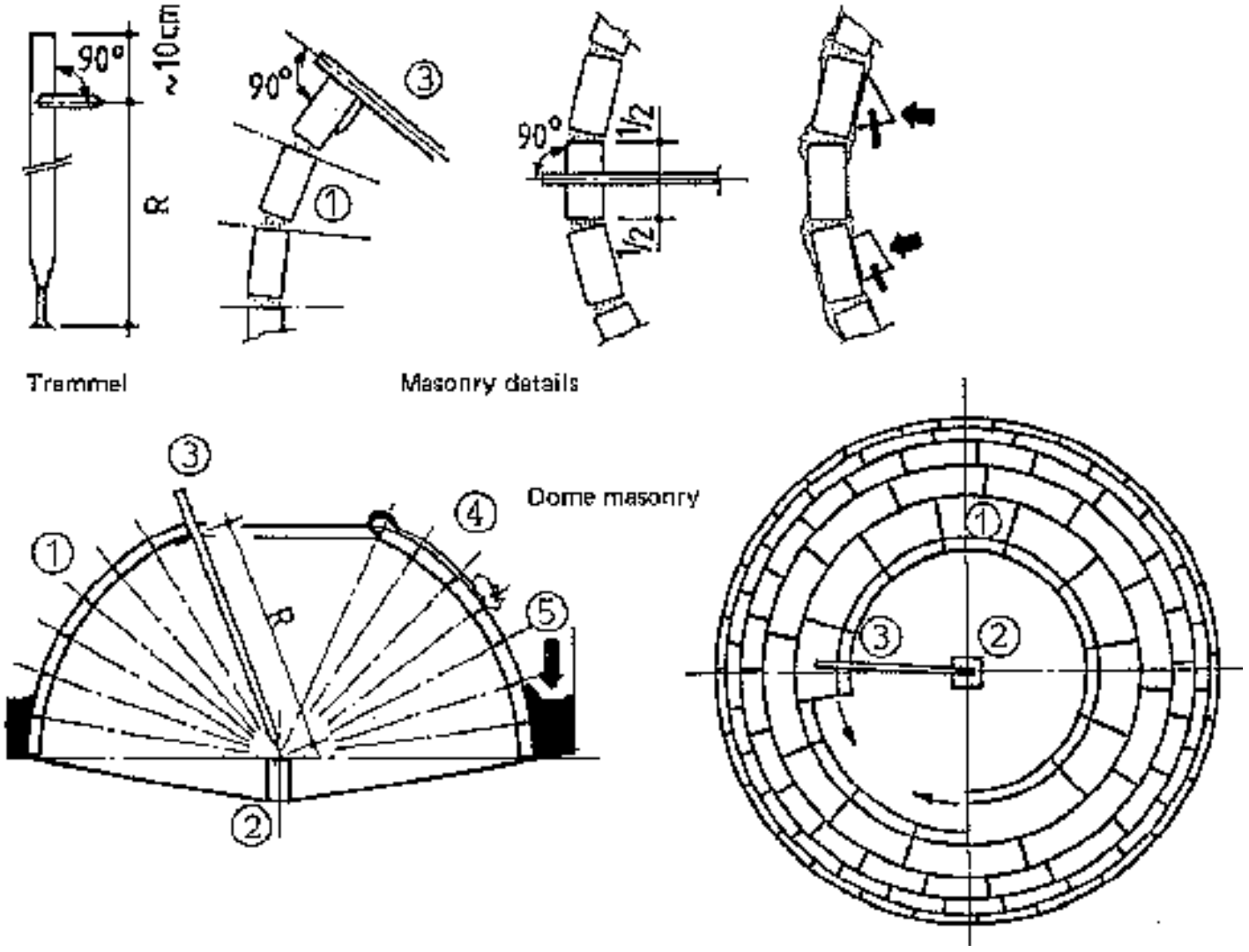


Fig. 5.21: Construction of a spherical dome from masonry. 1 Dome/masonry, 2 Establishing the centerpoint, 3 Trammel, 4 Brick clamp with counterweights, 5 Backfill (Source: Sasse 1984)

Dome

The dome of the biogas plant is hemispherical with a constant radius. Consequently, the masonry work is just as simple as for a cylinder and requires no falsework. The only accessory tool needed is a trammel.

The dome masonry work consists of the following steps:

- finding and fixing the centerpoint of the dome radius in relation to the level line
- layer-by-layer setting of the dome masonry, with the bricks set in mortar, positioned and aligned with the aid of the trammel and tapped for proper seating
- in the upper part of the dome - when the trammel is standing at a steeper angle than 45°, the bricks must be held in place until each course is complete. Sticks or clamps with counterweights can be used to immobilize them.

Each closed course is inherently stable and therefore need not be held in place any longer. The mortar should be sufficiently adhesive, i.e. it should be made of finely sieved sand mixed with an adequate amount of cement. **Table 5.9: Mortar mixing ratios (Source: Sasse, 1984)**

Type of mortar	Cement	Lime	Sand
Masonry mortar	2 :	1 :	10
Masonry mortar	1	:	6
Rendering mortar	1	:	4-8

Table 5.10: Suitability tests for rendering/mortar sands (Source: Sasse, 1984)

Test

1. Visual check for coarse particles

2. Determining the fines fraction by immersion in a glass of water: 1/21 sand mixed with

1. 1 litre water and left to stand for 1 h, after which the layer of silty mud at the top is measured.

3. Check for organic matter by immersion in an aqueous solution of caustic soda: 1/2 l sand in 1 1 3 %

caustic soda with occasional stirring. Notation of the water's color after 24 h.

Rendering

Mortar consisting of a mixture of cement, sand and water is needed for joining the bricks and rendering the finished masonry. Biogas plants should be built with cement mortar, because lime mortar is not resistant to water.

The sand for the mortar must be finely sieved and free of dust, loam and organic material. That is, it must be washed clean.

Special attention must be given to the mortar composition and proper application for rendering, since the rendering is of decisive importance with regard to the biogas plant's durability and leaktightness. Ensure that:

- trowelling is done vigorously (to ensure compact rendering) - all edges and corners are rounded off - each rendering course measures between 1.0 and 1.5 cm - the rendering is allowed to set|dry slowly (keep shaded and moist, as necessary) - the material composition is suitable and mutually compatible - a rated break ring is provided for a fixed-dome plant

Crack-free rendering requires lots of pertinent experience and compliance with the above points. Neither the rendering nor the masonry is gaslight and therefore has to be provided with a seal coat around the gas space (cf. chapter 5.4.4). 5.4.4 Gasholder

Basically, there are three different designs/ types of construction for gasholders used in simple biogas plants:

- integrated floating drums - fixed domes with displacement system and - separate gasholders

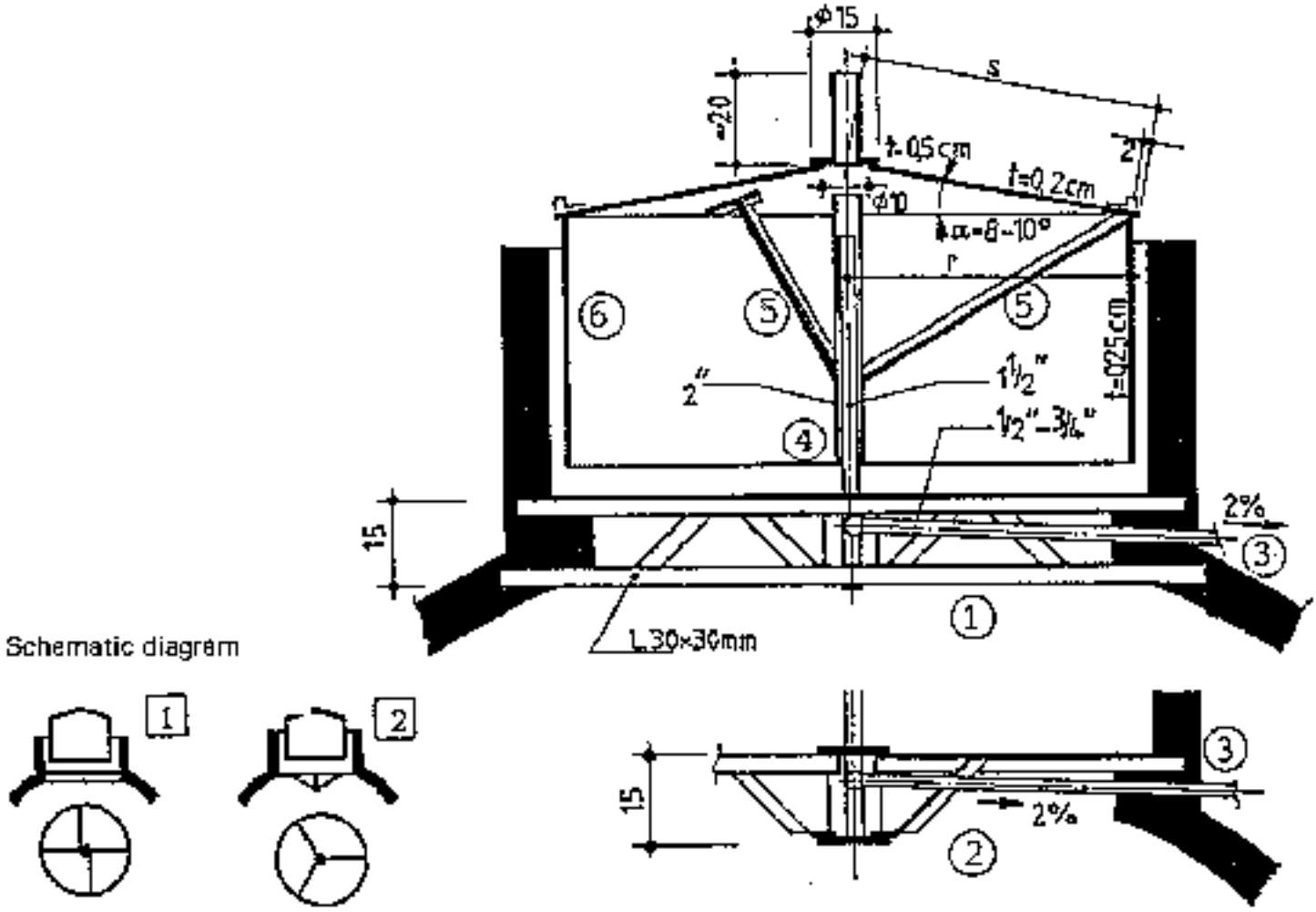


Fig. 5.22: Construction of a metal gasholder with internal guide frame. 1 Lattice beam serving as cross pole, 2 Cross pole with bracing, 3 Gas pipe (2% gradient), 4 Guide frame, 5 Braces for shape retention and breaking up the scum layer, 6 Sheet steel (2-4 mm) serving as the drum shell (Source: OEKOTOP/Sasse, 1984)

Floating-drum gasholders

Most floating-drum gasholders are made of 2 - 4 mm-thick sheet steel, with the sides made somewhat thicker than the top in order to counter the higher degree of corrosive attack. Structural stability is provided by L-bar bracing that simultaneously serves to break up surface scum when the drum is rotated.

A guide frame stabilizes the gas drum and keeps it from tilting and rubbing on the masonry. The two equally suitable types used must frequently are:

- an internal rod & pipe guide with a fixed (concrete-embedded) cross pole (an advantageous configuration in

connection with an internal gas outlet)
- external guide frame supported on three wooden or steel legs (cf. fig. 5.7).
For either design, it is necessary to note that substantial force can be necessary to turn the drum, especially if it is stuck in a heavy layer of floating scum. Any gasholder with a volume exceeding 5 or 6 m^3 should be equipped with a double guide (internal and external).
All grades of steel normally used for making gasholders are susceptible to moisture-induced rusting both inside and out. Consequently, a long service life requires proper surface protection consisting of:
- thorough derusting and desoiling. - primer coat of minium - 2 or 3 cover coats of plastic/bituminous paint.
The cover coats should be reapplied annually. A well-kept metal gasholder can be expected to last between 3 and 5 years in humid, salty air or 8-12 years in a dry climate.
Materials regarded as suitable alternatives to standard grades of steel are galvanized sheet metal, plastics (glass-reinforced plastic/ GRP, plastic sheeting) and ferrocement with a gaslight lining. The gasholders of waterjacket plants have a longer average service life, particularly when a film of used oil is poured on the water seal to provide impregnation.

Daily activities:

- fill the plant - clean the mixing pit - agitate the digester contents - check the gas pressure - check the gasholder contents - check the appearance and odor of the digested slurry

Weekly/monthly activities:

- remove/use the digested slurry - clean and inspect the gas appliances - check the gas valves, fittings and appliances for leaks - inspect the water trap

Annual activities:

- inspect the digester for scum formation and remove as necessary by opening the plant - inspect the plant for water tightness and gas tightness - pressure-test the gas valves, fittings and pipes - check the gasholder for rust and repaint as necessary.

Monitoring the process

If the plant is properly started before being handed over to the user, it may be assumed to be in proper working order. The user will have become familiar with what optimum plant operation involves. This is very important, because from then on he himself will have to watch for any appreciable changes in how the plant functions; the main indication of a beginning malfunction is a change in the daily gas output.

7.3 Plant maintenance

The maintenance scope for a biogas plant includes all work and inspections needed to ensure smooth functioning and long service life. To the extent possible, all maintenance work should be done by the user.

Biogas plants can develop a number of operational malfunctions. The most frequent problem, "insufficient gas production", has various causes. Often enough, it takes the work of a "detective" to locate and remedy the trouble. It may be necessary to experiment with and monitor the plant for months on end in cooperation with the user.

7.4 Plant repair

Repair measures for biogas plants (cf. table 7.4) are necessary in case of acute malfunctions and as indicated by routine monitoring. Repair measures exceeding simple maintenance work usually require outside assistance, since the user himself may not have the necessary tools or know-how.

It is advisable to have the annual maintenance work mentioned in chapter 7.3 performed by external artisans With prior experience in biogas technology. Such maintenance and repair work should be ordered on a contract basis. Past project experience shows that professional biogas repair and maintenance services can be very important for ensuring long-term plant performance. Such services should include general advice, functional testing, troubleshooting, spare-parts delivery and the performance of repair work.

Table 7.4: Simple-plant malfunctions and remedial measures (Source: OEKOTOP)

Problem	**Possible cause**	**Countermeasures**
Plugged-up inlet pipe	fibrous substrate	use rod to unplug the pipe
Stuck gasholder	floating scum	1. turn the gasholder
		2. take off the gasholder
		and remove the scum
Tilted gasholder	broken guideframe	repair
Low gas production, poor gas quality	cf. table 7.3	cf. table 7.3
Receding slurry level	leak in plant	repair
Inadequate gas storage in fixed-dome	leak in gasholder	repair
Plants		

Stuck gas cocks	Corrosion	apply oil, ,operate repeatedly
Leaky gas pipe	corrosion, inferior workman-	repair
	Ship	
Sudden loss of gas	- broken gas line	repair
	- blown-off water trap	refill with water
	- open gas cock	close
Pulsating gas pressure	water in the gas pipe	pump out the pipe, relocate that
		section of pipe
	plugged-up gas pipe	push rod through pipe
Malfunctioning gas appliances	cf. chapter 5.5.3	cf. chapter 5.5.3
Structural damage	cf. table 7.1	cf. table 7.1

5.6 Measuring methods and devices for biogas plants

The purpose of conducting measurements on a biogas plant is to enable timely detection of developing problems, adjustment to optimum operating conditions, and gathering of practical 'data for comparison with those of other plants. The following variables can be measured quickly and easily:

- gas production via dry gas meter or by measuring the fill level of the gasholder - weight of inputs via a hand-held spring scale - temperature via an ordinary stem thermometer or electronic temperature sensor - total-solids content by drying a sample at 104 °C and weighing the residue on a precision balance - H_2S content of the gases via a gas test tube - pH via litmus paper.

The contents of the substrate/slurry can only be determined by a special laboratory.

Various levels of precision are recommended, depending on the set objective and corresponding time, effort and equipment expenditure.

Observation by the user

Procedure - measuring the gas consumption through daily checking of the calibration marks on the gasholder - measuring the daily input quantities via defined-volume vessels - measuring the air/slurry temperature with a thermometer.

Documentation Daily notation of measured values.

Interpretation/results Daily gas production as a function of substrate input and temperature.

Field testing by the extension officer

Procedure - installation and daily reading of a dry gas meter to determine the rate of gas production - random sampling of the CO_2 and H_2S contents of the biogas - determination of quantities added by weighing the moist mass and water on a spring scale - random sampling to determine the total solids content of the substrate - measuring the digester temperature with the aid of a remote electronic thermometer - measuring the ambient temperature with a mini-max thermometer - determining pH levels via litmus paper - laboratory testing to determine the C/Nratio, volatile solids content and manurial quality of digested slurry.

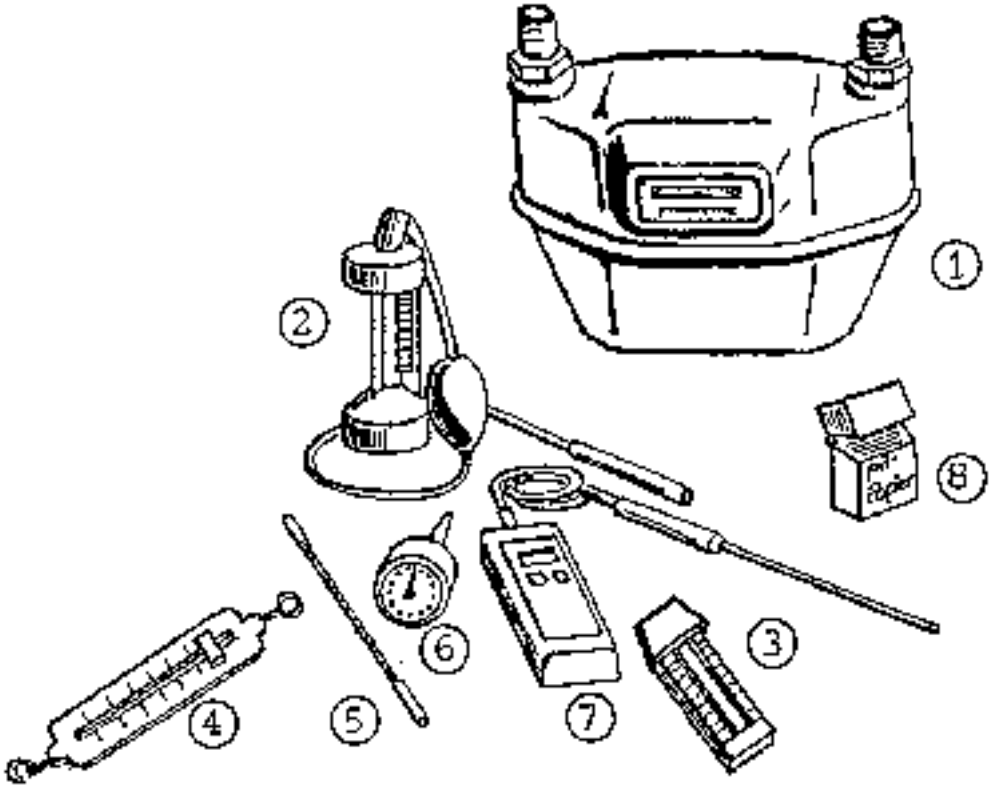


Fig. 5.38: Measuring instruments for biogas field tests. 1 Gas meter, 2 CO2 tester, 3 Mini-max thermometer, 4 Spring scale, 5 Stem thermometer, 6 Insertable thermometer, 7 Electric remote thermometer, 8 Litmus paper (Source: OEKOTOP)

Documentation Daily entry of measured values in a log book.

Interpretation of results - time history of daily gas production as a function of temperature and substrate input - time history of specific gas yield (Gy = m^3 gas/kg TS) and of specific gas production (m^3 gas/m^3 Vd) as a function of temperature - time history of pH - time history of maximum and minimum ambient

temperatures, i.e. mean monthly and annual temperatures, plus extremes.

6. Large-scale biogas plants

Biogas technology, or better: anaerobic-process engineering, Is becoming increasingly important as a means of treating and cleaning industrial organic waste materials and highly loaded organic wastewater.

This applies in particular to the following ranges of production:

- large-scale stock farming

- industrial processing of agricultural produce (refining of sugar, production of starch, winning of fibers, processing of coffee, generation of alcohol, slaughterhouses, etc.)

- industrial and urban refuse and sewage (manufacturing of paper, organic household waste, sewage sludge, biotechnological industries).

Most biogas plants used in those areas are large-scale plant systems with volumes ranging from several hundred to several thousand cubic meters.

Compared to aerobic treatment, anaerobic processes offer comparable performance with regard to purification capacity and conversion rates, but also stand apart from the former in that they:

- require less energy to keep the process going and to generate useful energy in the form of biogas, and

- produce less organic sludge, because the growth rate of anaerobic microorganisms is slower than that of aerobic microorganisms.

Consequently, anaerobic treatment of waste materials and wastewater offer some major advantages for a comparable initial invest" meet. Nonetheless, much of the technology has not yet passed the testing stage.

Due to the size of plant, different objectives and special requirements concerning operation and substrates, the anaerobic treatment of waste materials and wastewater involves a different set of planning mechanisms, plant types and implementational factors. To go into detail on this subject would surpass the intended scope of this manual; besides, extension officers hardly need expect to be confronted with the job of planning such plants. Nevertheless, some basic information is offered here to give the reader a general grasp of what large-scale biogas technology involves.

In discussing the various waste-treatment options, differentiation is made between wastewater (organic - highly loaded) and waste materials/residues (organic solids).

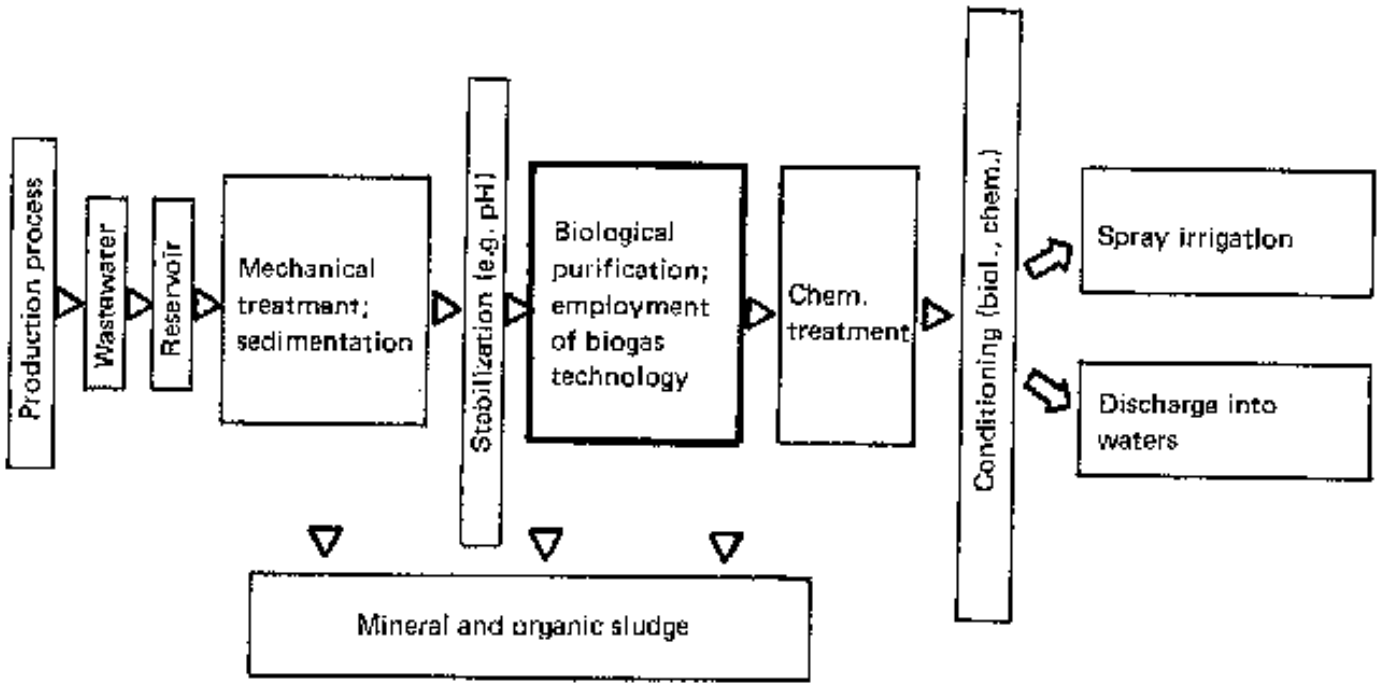


Fig. 6.1: Basic principle of organic wastewater treatment (Source: OEKOTOP)

Table 6.1: Some examples of biogas production from agro-industrial residues and wastewater (Source: OEKOTOP, compiled from various sources)

Area of production	**Retention time**	**Digester loading**	**Gas production**		**Degradation rate**
	[d]	**[kg/m³ X d]**	**[m³/kg]**	**[m³/m³ X d]**	**[%]**
Slaughterhouse	0.5- 8.5	1.2-3.5 COD	0.3-0.5 COD	0.1 - 2.4	80 COD
Fruit and vegetables	32.0	0.8-1.6 VS	0.3-0.6 VS	-	-
Olive-oil extraction	20.0-25.0	1.2-1.5 TS	0.7 BOD	-	80-85 BOD
Whey	2.0-5.0	6.4 BOD	0.9 BOD	5.5	92 BOD
Potato starch	-	7.5 COD	0.3-0.4 COD	-	90-95 BOD
Yeast factory	0.5-0.7	1.0-8.0 COD	-	0.5-4	60-70 COD
Sugar mill	0.2-1.0	12.0-16.5 COD	-	-	87-97 COD

Milk processing	3.4-7.4	0.7-2.0 VS	0.1-0.4 VS	-	86-99 BOD
Molasses slop	10.0	3.9 VS	0.9 VS	3.5	97 BOD
Molasses distillery	1.2-3.5	18.3 COD	0.6 COD	6.6	45-65 COD
Brewery	2.3-10.0	1.8-5.5 TS	0.3 - 0.4 TS	-	-
Tannery	0.5	2.7-31.9 COD	-	-	80-91 COD
Pharmaceut.ind.	0.5-2.0	0.2-3.5 COD	0.6 COD	0.1-2.5	94-98 COD
Refuse + sewage sludge	11.0-22.5	1.2-3.1 VS	1.0 VS	-	-
Refuse	25.0-30.0	0.7-3.2 VS	0.1-0.4 VS	-	-
Cattle farming	15.0-35.0	0.5-2.5 VS	0.2-0.4 VS	0.6-1.4	-
Pig farming	10.0-25.0	0.8-4.1 VS	0.1-0.5 VS	0.8-2.1	-
Poultry farming	15.0-35.0	0.6-3.6 VS	0.2-0.5 VS	0.7-1.8	-
Sewage sludge	20.0-30.0	1.2-4.5 VS	0.1-0.6VS	0.8-1.5	-

Wastewater treatment

Organically contaminated wastewater contains mostly dissolved substances that are measured in terms of COD (chemical oxygen demand) and BOD (biochemical oxygen demand, i.e. oxygen required for mineralizing the organic contents).

The main purpose of wastewater treatment is to remove or mineralize the organic substances, i.e. to prepare them for release into a receiving body of water or the agricultural environment.

Anaerobic fermentation serves as the biological purifying process. Purification performance rates of up to 95% BOD are achievable. The choice of process and the achievable purification performance rates are determined by the type and composition of the substrate/wastewater. In general, dissolved organic substances are readily biodegradable. Retention times ranging from a few hours to a few days are not uncommon. On the other hand, some organic substances are hard to break down (paints, aromates, etc.), while others are toxic and/o,r capable of causing a shortage of nutrients and adverse medium characteristics (e.g. pH-shifts). A number of special-purpose processes have been developed for use in anaerobic wastewater treatment in order to compensate for the high hydraulic loads and lack of bacterial colonization areas:

Contact fermenter

Digested slurry is recycled through a continuously stirred reactor in order to maintain a high level of bacterial concentration and, hence high performance. The contact process is a suitable approach for both mobile substrates and substrates with a high concentration of solids.

Upflow fermenter An upflow-type fermenter with a special hydraulic configuration serves simultaneously as a suspended-solids filter with a high bacterial density and correspondingly high biodegradation performance.

Fluidized-bed fermenter A vehicle (balls of plastic or clay) is kept "floating" in the fermenter to serve as a colonizing area for the bacteria.

Fixed-bed fermenter A vehicle (plastic pellets or lumps of clay, rock or glass) provides a large, stationary colonization area within the fermenter. Fixed-bed fermenters are suitable for wastewater containing only dissolved solids. If the wastewater also contains suspended solids, the fermenter is liable to plug up.

Two-phase fermentation The acidic and methanogenic phases of fermentation are conducted separately, each under its own optimum conditions, in order to maximize the fermentation rates and achieve good gas quality.

The treatment of wastewater marked by heavy organic pollution must always be looked upon as an individual problem that may require different processes from one case to the next, even though the initial products are identical. Consequently, trials must always be conducted for the entire chain: production process - purification - wastewater utilization - and energy supply/ use.

Thanks to their uncomplicated, robust equipment, the contact process and fixed-bed fermentation stand the best chance of success in developing countries.

Waste materials/residues The fact that practically identical production processes often yield residues that hardly resemble one another also applies to industrial waste materials. Here, too, pretrials and individual, problem-specific testing are called for in any case.

The potential range of organic waste materials is practically unlimited. Of particular interest for the purposes of this manual, however, are waste materials from factory farms and slaughterhouses.

Large-scale stock farming The characteristics of dung from cattle, pigs and chickens were described in chapter 3.2. In factory farming, the dung yield is heavily dependent on the given type of fodder and how the stables are cleaned. Thus, pinpoint inquiries are always necessary.

The large quantities of substrate, often exceeding 50 m^3/d, lead to qualitative differences in the planning and implementation of large-scale plants, as opposed to small-scale plants. This has consequences with regard to substrate handling and size of plant:

- Daily substrate-input volumes of more than 1 m^3 cannot be managed by hand. Pumps for filing the plant and machines for chopping up the substrate are expensive to buy and run, in addition to being susceptible to wear & tear. In many cases, careful planning can make it possible to use gravity-flow channels for filling the plant.

- Plants of a size exceeding 100 m^3 usually cannot be made of masonry, i.e. the types of plant discussed in chapter 5 cannot be used.

The choice of plant is limited to either the mechanized types used in industrial countries or simple, large-scale plants. Experience shows that most simple, large-scale plants are - of modular design, - usually equipped with channel digesters, - and require the use of substrate from which the scum-forming material has been removed in order to get by with either low-power mechanical mixers or none at all.

Since large-scale biogas plants produce accordingly large volumes of biogas, the generation of electricity with the aid of a motor-generator set is of main interest.

The two Ferkessedougou biogas plants situated in the northern part of Cote d' Ivoire stand as examples of a successful large-scale biogas-plant concept based on a simple design. They have been in operation at the local cattle-fattening station and slaughterhouse since 1982 and 1986, respectively, where they serve in the disposal of some of the excrements produced by an average number of 2500 head of cattle. The plant consists of a simple, unlined earth-pit digester with a plastic-sheet cover serving as gasholder. The gas is used for generating electricity, heating water and producing steam.

7.1 Commissioning of biogas plants

The commissioning procedure for a biogas plant includes: - inspection and final acceptance of all components - initial filling - starting the plant - user familiarization. Inspection and final acceptance.

Prior to filing the plant, all components must be carefully inspected for proper function and suitability for acceptance. Of particular importance at the time of final acceptance is seal testing of the digester, gasholder and gas pipes.

It must be kept in mind that the seal tests described below are very laborious without pumps (e.g. hauling of more than 10 m^3 water) and may not even be feasible if water is scarce, in which case such testing must be dispensed with. The time and effort involved must be weighed against the risk of having to empty the plant after completely filling it with slurry. In either case, it is very advisable to use a motor pump.

Water-seal testing Fill the entire digester with water and check the fill level in all components.

Once all components have become saturated with water (after about 1 day), refill to the zero line, wait one day, and then remeasure. If the water loss amounts to less than 2% of the digester volume, the plant may be regarded as leaktight.

Seal testing (water and gas) of a fixed-dome plant Fixed-dome plants are regarded as leaktight if the water-

seal test shows less than 2% water loss, and the gas-seal test shows less than 5% gas loss.

Gas-seal testing of a floating-drum plant In the case of floating-drum plant, only the metal gasholder must be subjected to gas seal testing; any leaks are detected with the aid of soap water.

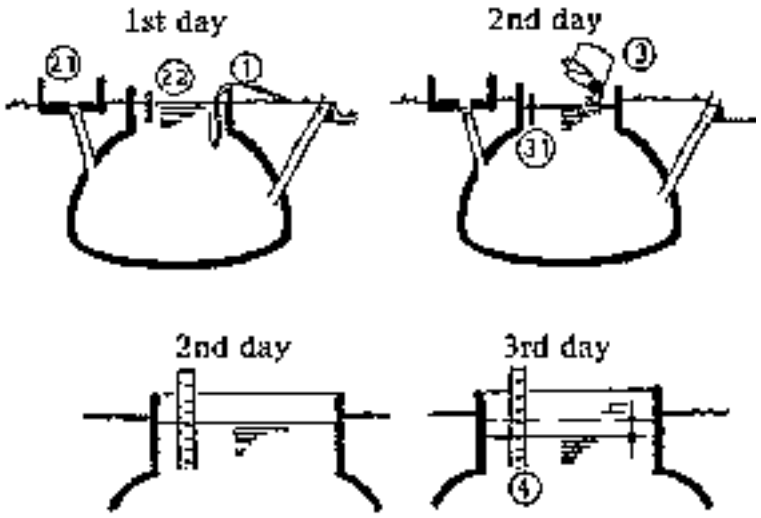


Fig. 7.1: Water-seal testing of a digester. 1 Fill the plant with water, Check the fill levels: 21 Inlet no water in the mixing pit, 22 Digester - at least 10 cm neck height above water level. 3 Refill to compensate for moisture absorbed by the masonry. 31 Mark the water level. 4 Measure the drop in water level as basis for calculating the water loss (W1 = p r^2 X h). 5 Repeat measurements as necessary. (Source: OEKOTOP)

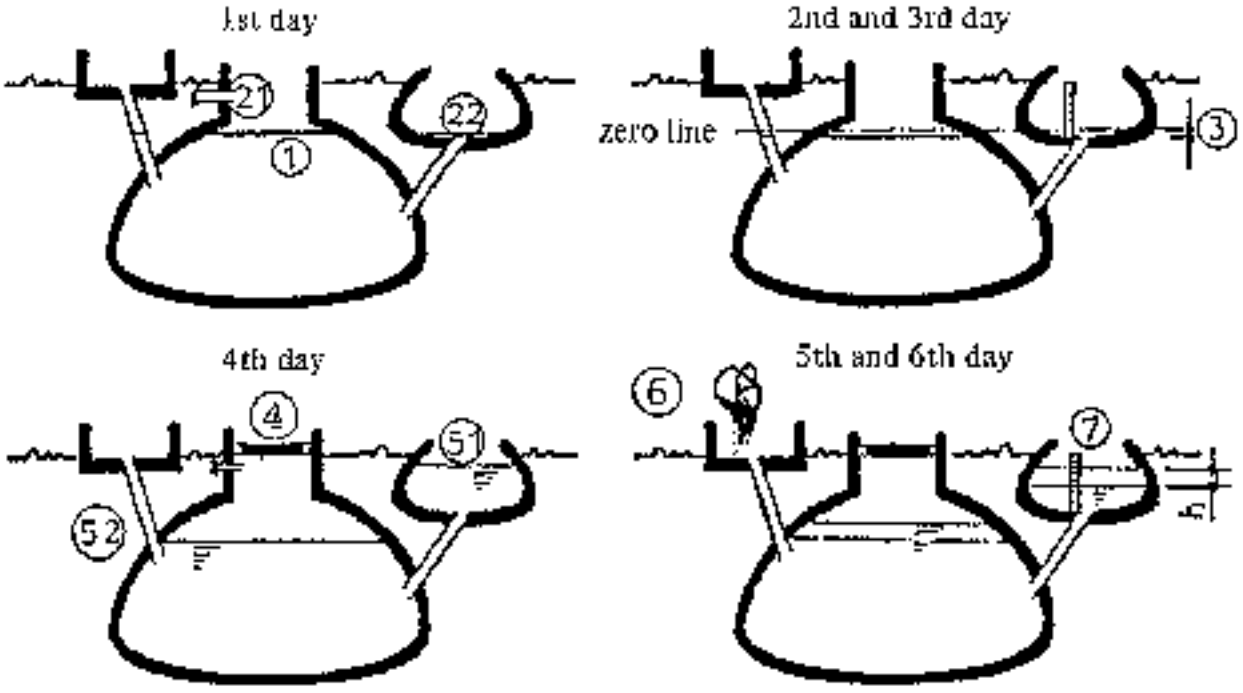


Fig. 7.2: Seal testing (water and gas) of a fixed-dome plant. 1 Fill the plant up to the zero line; Check the fill levels: 21 Gas extraction points at least 10 cm above discharge level, 22 Water level in the displacement pit. 3

Perform water-seal test and level-drop check (cf. fig. 7.1). 4 Close the entry hatch. 5 Fill with gas up to maximum a1lowable plant pressure a) with air (pump), b) with exhaust gas (vehicle exhaust), 51 . . . until the displacement pit overflows, or 52 . . . until gas bubbles out of the inlet pipe. 6 Refill the plant to compensate for saturation losses. 7 Measure the level drop (h) after one day, and calculate the gas losses. (Source: OEKOTOP)

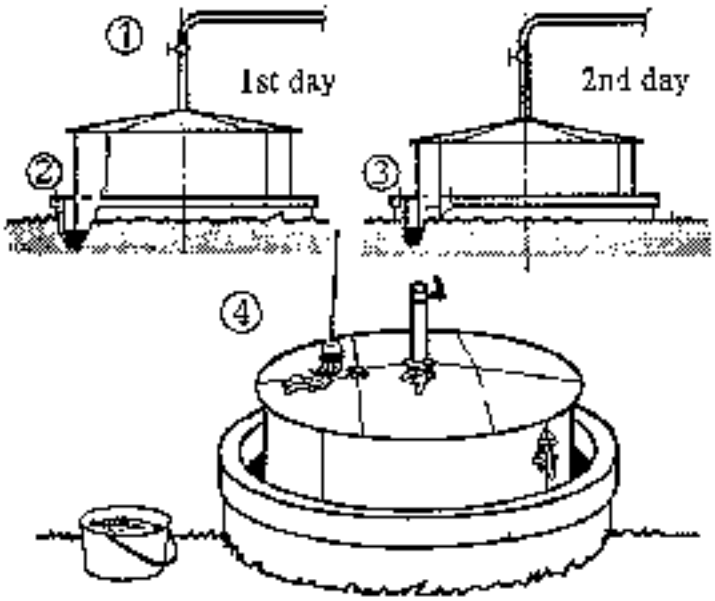


Fig. 7.3: Gas-seal testing of a metal gasholder. 1 Place the gasholder in position with the gas valve closed. 2 Mark the top edge of the digester neck on the gasholder. 3 Check the location of the mark one day later. 4 If the mark is found to have dropped by 1-3 cm, use soapy water to check for leaks in the gasholder. (Source: OEKOTOP)

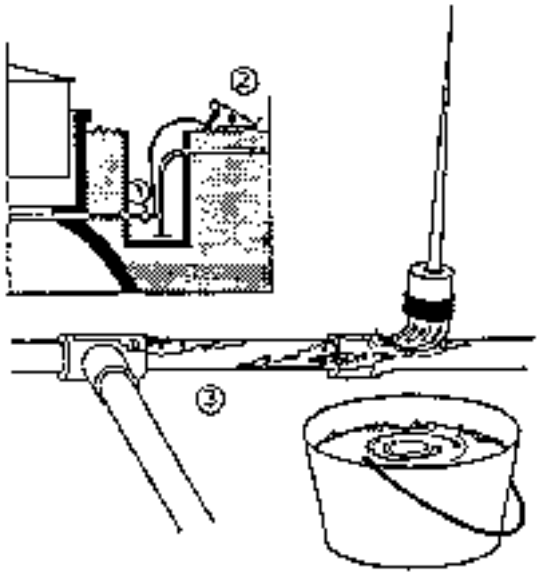


Fig. 7.4: Pressure testing a gas pipe. 1 Close all gas valves and fill the water trap. Find the maximum pipe pressure, i.e. how high the pressure in the pipe can go until the water trap blows off (not more than 50

cmWG). 2 Adjust the test pressure with the aid of a manometer-equipped test pump or the gasholder (10% below max. pressure). Check the pressure loss after one day. 3 Use soapy water to detect leaks. (Source: OEKOTOP)
Pressure testing of the gas pipe The test must be performed while all gas pipe connections are still accessible. Pressurize the gas pipe with the aid of a test pump or by placing weights on the gasholder. If there is no noticeable loss of gas after one day, the pipe may be regarded as gaslight.
Initial filling of the plant
The initial filling for a new biogas plant should, if possible, consist of either digested slurry from another plant or cattle dung. It is advisable to start collecting cattle dung during the construction phase in order to have enough by the time the plant is finished. When the plant is being filled for the first time, the substrate can be diluted with more water than usual.
Starting the plant
Depending on the type of substrate in use, the plant may need from several days to several weeks to achieve a stable digesting process. Cattle dung can usually be expected to yield good gas production within one or two days. The breaking-in period is characterized by:
- low-quality biogas containing more than 60% CO_2 - very odorous biogas - sinking pH end - erratic gas production.
The digesting process will stabilize more quickly if the slurry is agitated frequently and intensively. Only if the process shows extreme resistance to stabilization should lime or more cattle dung be added in order to balance with pH. No additional biomass should be put into the biogas plant during the remainder of the starting phase. Once the process has stabilized, the large volume of unfermented biomass will give rise to a high rate of gas production. Regular loading can commence after gas production has dropped off to the intended level.
As soon as the biogas becomes reliably combustible, it can be used for the intended purposes. Less-than-optimum performance of the appliances due to inferior gas quality should be regarded as acceptable at first. However, the first two gasholder fillings should be vented unused for reasons of safety, since residual oxygen poses an explosion hazard.

User familiarization
The plant owner should be familiarized with the details of plant operation and maintenance at the time of commissioning. It is important that he be not only familiarized with the theory of function but given ample opportunity to practice using all parts of the plant. The user-familiarization procedure should be built up around an operational/maintenance checklist (cf. table 7.2).

7.2 Plant operation

The operation of a simple biogas plant is relatively uncomplicated. The user must be given all the information and practical assistance he needs before and during the early phases of plant operation.

Collecting substrate

The collection of substrate is a simple matter when combined with work that has to be done anyway, e.g.

cleaning the stables. It can be made even easier by arranging for the manure to flow directly into the mixing pit. Experience shows that it is not a good idea to gather dung from fields, roads, etc. or to go to the trouble of elaborately chopping up or otherwise preprocessing plant material for use as substrate. The work involved is usually underestimated, while the motivation is overestimated.

Filling the plant

Filling means: mixing the substrate with water, removing bouyant materials, allowing the fill material to warm up, flushing it into the digester, and removing sand and stones. The simple mixing pit shown in figure 5.16 can handle a daily fill quantity of up to 500 1.

Digested-slurry storage/utilization

The further processing of digested slurry is a critical point in that it can be quite toilsome (cf. chapter 3.4).

In designing the plant, care must be taken to ensure that the slurry store will be large enough. Fixed-dome plants in particular should be equipped with an overflow, so that the digested slurry does not have to be hauled away every day. **Table 7.2: Checklist for the daily operation and regular maintenance of biogas plants (Source: OEKOTOP)**

Daily activities: - fill the plant - clean the mixing pit - agitate the digester contents - check the gas pressure - check the gasholder contents - check the appearance and odor of the digested slurry

Weekly/monthly activities: - remove/use the digested slurry - clean and inspect the gas appliances - check the gas valves, fittings and appliances for leaks - inspect the water trap

Annual activities: - inspect the digester for scum formation and remove as necessary by opening the plant - inspect the plant for water tightness and gas tightness - pressure-test the gas valves, fittings and pipes - check the gasholder for rust and repaint as necessary

Monitoring the process

If the plant is properly started before being handed over to the user, it may be assumed to be in proper working order. The user will have become familiar with what optimum plant operation involves. This is very important, because from then on he himself will have to watch for any appreciable changes in how the plant functions; the main indication of a beginning malfunction is a change in the daily gas output.

7.3 Plant maintenance

The maintenance scope for a biogas plant includes all work and inspections needed to ensure smooth

functioning and long service life. To the extent possible, all maintenance work should be done by the user.

Biogas plants can develop a number of operational malfunctions. The most frequent problem, "insufficient gas production", has various causes. Often enough, it takes the work of a "detective" to locate and remedy the trouble. It may be necessary to experiment with and monitor the plant for months on end in cooperation with the user.

7.4 Plant repair

Repair measures for biogas plants (cf. table 7.5) are necessary in case of acute malfunctions and as indicated by routine monitoring. Repair measures exceeding simple maintenance work usually require outside assistance, since the user himself may not have the necessary tools or know-how.

It is advisable to have the annual maintenance work mentioned in chapter 7.3 performed by external artisans With prior experience in biogas technology. Such maintenance and repair work should be ordered on a contract basis. Past project experience shows that professional biogas repair and maintenance services can be very important for ensuring long-term plant performance. Such services should include general advice, functional testing, troubleshooting, spare-parts delivery and the performance of repair work. **Table 7.3: Checklist for troubleshooting in case of insufficient gas production (Source: OEKOTOP)**

Quantity and quality of substrate - low/less daily input - excessive dilution with water Ascertain by control measurements

Gas system leaks - gasholder - gas pipe - valves and fittings Ascertain by checking all components and connections for leaks with the aid of soapy water

Disturbance of the biological process Indications: - heavy odor - change of color of digested material - drop in pH

Possible remedial measures: - inspect the quality of the substrate - stop biomass until the process returns to normal - stabilize the pH, e.g. with lime - add cattle dung or healthy slurry - investigate the user's filling methods to determine if pollutants or noxious substances (detergents, pesticides, etc.) are getting into the plant **Table 7.4: Simple-plant malfunctions and remedial measures (Source: OEKOTOP)**

Problem	**Possible cause**	**Countermeasures**
Plugged-up inlet pipe	fibrous substrate	use rod to unplug the pipe
Stuck gasholder	floating scum	1. turn the gasholder

		2. take off the gasholder
		and remove the scum
Tilted gasholder	broken guideframe	Repair
Low gas production, poor gas quality	cf. table 7.3	cf. table 7.3
Receding slurry level	leak in plant	Repair
Inadequate gas storage in fixed-dome	leak in gasholder	Repair
plants		
Stuck gas cocks	corrosion	apply oil, ,operate repeatedly
Leaky gas pipe	corrosion, inferior workman-	Repair
	ship	
Sudden loss of gas	- broken gas line	Repair
	- blown-off water trap	refill with water
	- open gas cock	Close
Pulsating gas pressure	water in the gas pipe	pump out the pipe, relocate that
		section of pipe
	plugged-up gas pipe	push rod through pipe
Malfunctioning gas appliances	cf. chapter 5.5.3	cf. chapter 5.5.3
Structural damage	cf. table 7.1	cf. table 7.1

8.3 Micro-economic analysis for the user

The following observations regarding micro-economic analysis (static and dynamic) extensively follow the methods and calculating procedures described in the pertinent publication by H. Finck and G. Oelert, a much-used reference work at Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) GmbH that should be consulted for details of interest. **Table 8.2: Investment-cost comparison for various biogas plants (Source: OEKOTOP)**

Cost factor	**Water-jacket. Plant**	**Fixed-dome plant**	**Plastic-sheet plant**
Cost per m^3 digester (DM)	200-400	150 - 300	80-120
including:Gasholder	23 %	(part of digester)	8%
Digester/slurry store	35%	50%	42%
Gas appliances/piping	22%	24%	36%
Stable modification	8%	12%	-
General engineering	12%	14%	14%

Surrey of the monetary costs and benefits of a biogas plant

Figure 8.2 shows a breakdown of the basic investment-cost factors for a - presumedly - standardized fixed-dome plant. The cost of material for building the digester, gasholder and displacement pit (cement, bricks, blocks) can, as usual, be expected to constitute the biggest cost item. At the same time, the breakdown shows that the cost of building the plant alone, i.e. without including the peripherals (animal housing, gas appliances, piping) does not give a clear picture.

For a family-size plant, the user can expect to pay between 80 and 400 DM per m^3 digester volume (cf. table 8.2). This table shows the total-cost shares of various plant components for different types of plant. While the average plant has a service life of 10-15 years, other costs may arise on a recurrent basis, e.g. painting the drum of a floating-drum plant and replacing it after 4 - 5 years. Otherwise, the operating costs consist mainly of maintenance and repair work needed for the gas piping and gas appliances. At least 3% of the initial investment costs should be assumed for maintenance and repair.

The main benefits of a biogas plant are:

- savings attributable to less (or no) consumption of conventional energy sources for cooking, lighting or cooling

- the excess energy potential, which could be commercially exploited

- substitution of digested slurry in place of chemical fertilizers and/or financially noticeable increases in crop yields

- savings on time that can be used for wage work, for example.

Usually, a biogas plant will only be profitable in terms of money if it yields considerable savings on conventional sources of energy like firewood, kerosene or bottled gas (further assuming that they are not subsidized).

Financially effective crop-yield increases thanks to fertilizing with digested slurry are hard to quantify, i.e. their accurate registration requires intensive observation of the plant's operating parameters.

Such limitations make it clear that many biogas plants are hardly profitable in monetary terms, because the relatively high cost of investment is not offset by adequate financial returns. Nonetheless, if the user considers all of the other (non-monetary) benefits, too, he may well find that operating a biogas plant can be worth his while. The financial evaluation (micro-economic analysis), the essential elements of which are discussed in the following chapter, therefore counts only as one of several decision-making instruments to be presented to the potential user.

The main advisory objective is to assess the user's risk by calculating the payback period ("How long will it take him to get back the money he invested?") and comparing it with the technical service life of the plant. Also, the user must be given some idea of how much interest his capital investment will carry (profitability calculation).

The micro-economic analytical methods described in the following subsections require the highest achievable accuracy with regard to the identification of costs and benefits for the biogas plant under consideration. Chapter 10.4 in the appendix includes an appropriate formsheet for data collection. With a view to better illustrating the described analytical methods, the formsheet (table 10.10) includes fictive, though quite realistic, data concerning a familysize biogas plant. Those data are consistently referred to and included in the mathematical models for each of the various sample analyses.

Calculation of the static payback period according to the cumulative method (data taken from the appendicized formsheet, table 10.10).

Input parameters: - investment costs - annual revenues - less the yearly operating costs - less the external capital costs = annual returns

The cumulative method allows consideration of different annual returns.

Calculatory procedure: The investment expenditures and annual returns are added together until the line-3 total in table 8.3 either reaches zero (end of payback period) or becomes positive.

Evaluation: As far as risk minimization is concerned, a short payback period is very valuable from the

standpoint of the plant's user ("short" meaning significantly less than 10 years, the data listed in table 8.3 pegs it at 5.5 years). Should the analysis show a payback period of 10 years or more, thus possibly even exceeding the technical service life of the plant, building the plant could not be recommended unless other important factors are found to outweigh that disadvantage.

Year	0	1	2	3	4	5	6 etc.
Item							
1. Investment expenditures	-1.100						
2. Annual returns		+200	+200	+200	+200	+200	+200
3. Cumulative value	-1.100	-900	-700	-500	-300	-100	+100

Table 8.3: Schedule of data for calculating the plant payback period (with case example; data taken from the appendicized formsheet, table 10.l0) (Source: OEKOTOP)
Static calculation of profitability (data taken from table 10.10 in the Appendix)
Input parameters: - average capital invested per time interval, KA

$$K_A = \frac{\text{initial investment}}{2} = \frac{I_o}{2}$$

- net profit, NP = annual return - less the external capital servicing costs - less the depreciation

Calculatory procedure: The profitability, or return on investment, ROI, is calculated according to the following formula

$$ROI = \frac{NP}{K_A} \cdot 100$$

The linear annual depreciation amounts to:

$$\frac{I_o}{\text{service life}}$$

The technical service life of a biogas plant generally amounts to 10-15 years. It is advisable to calculate twice, one for a pessimistic assumption (10-year service life) and once for an optimistic assumption (15-year service life). Similarly, the net profit should also be varied under pessimistic and optimistic assumptions.

Evaluation: The user can at least expect the biogas plant to yield a positive return on his invested capital. The actual interest should be in the range of locally achievable savings-account interest. Also, the results of profitability calculation can be used to compare the financial quality of two investment alternatives, but only if their respective service lives and investment volumes are sufficiently comparable.

Calculating the profitability using the appendicized data

Initial investment, Io = 1100 Average capital invested, KA =Io / 2 = 550 Annual returns = 200 Loan servicing costs = none (internal financing) Depreciation for 10 year service life = 110(case 1) Depreciation for 15 year service life = 73.3 (case 2) Net profit, NP1, for case 1 = 90 Net profit, NP2, for case 2 = 126.7 Return on investment in case 1 = NP_1 / K_A = 16% Return on investment in case 2 = NP_2 /KA = 23%

Thus, this sample calculation can be expected to show positive results regarding the achievable return on invested capital.

8.4 Use of complex dynamic methods

Dynamic methods of micro-economic analysis are applied to biogas plants primarily by:

- extension officers, for the purpose of checking, by a dynamic technique, their own results of static monetary analysis (cf. chapter 8.3), as already explained to the small farmers and other users of biogas plants

- banks, as a decision-making criteria in connection with the granting of loans

- operators of large-scale biogas plants, for whom the financial side of the investment is an important factor in the decision-making process.

Item	Period	0 19..	1 19..	2 19..	3 19..	...	10 19..
Investment expenditures		−1.100					
Returns			+200	+200	+200	..	+200
Discounting factor[1] (for i = 10%)			0.909	0.826	0.751	..	0.386
Present value			+182	+165	+150	..	+77
Cumulative value[2]		−1.100	−918	−753	−603	..	+129

[1] As taken from table 10.11 in the Appendix
[2] Simultaneously enabling dynamic payback calculation

Table 8.4: Schedule of data for net-present-value calculation (with case example, data taken from the appendicized formsheet, table 10.10; Source: OEKOTOP)

The importance of the dynamic methods lies in the fact that the results obtained using the simpler static methods of calculation described in chapter 8.3 can become problematic, if the point in time at which payments become due is of increasing importance. Any investor naturally will set a lower valuation to revenues that are due a decade from now than to those which are coming in at present. Consequently, he would want to compound past payments and discount future payments to obtain their respective present values.

Net-present-value method

The most commonly employed method of dynamic micro-economic analysis is the net-present-value method used by many extension officers. It enables evaluation of both the absolute and relative advantages of a biogas-plant investment (as compared to other investment alternatives) on the basis of the anticipated minimum interest rate above and beyond the net present value of the investment. Simultaneously, the netpresent-value method also serves as a basis for calculating the dynamic payback period and for calculations based on the annuities method. (For details on the net-present-value and other dynamic methods of calculation, please refer to the aforementioned publication by Finck/Oelert.)

The inflation problem: Either the entire calculation is based on nominal incomes and expenditures, and market interest rates (= calculatory interest) are assumed, or the income and expenditures are presumed to remain constant, and the calculation is based on the real interest rate. The latter is calculated according to the following formulae (p = market rate of interest and a = rate of inflation):

$$i = \frac{100 + p}{100 + a} \cdot 100 - 100$$

Example: market rate of interest = 48%; rate of inflation = 34%

i = [(100 + 48)/(100 +34)]* 100-100=10.4%

Discounting factors: The compounding and discounting factors for the net-present-value method are shown in table 10.11 (Appendix) for interest rates of 1-30% and service lives of 1-15 years. Calculatory procedure: The following information is drawn from the appendicized data survey: calculatory rate of interest, i (item 1.3); investment costs, I (item 2) and the returns (item 8). Much like the static mathematical models discussed in chapter 8.3, the calculatory procedures are again made more readily understandable by inserting the appropriate data from the formsheet (table 10.10, Appendix). In a real case, those data naturally would have to be replaced by the actual on-site data.

Results: The biogas plant can be regarded as profitable, if its net present value is found to be equal to or greater than zero for the minimum acceptable interest rate, e.g. i= 10%. The net present value is arrived at by cumulating the cash-flow value. Among several alternative investments, the one with the highest net present value should be chosen.

Sample calculation: For a plant service life of 10 years (conservative estimate), the cash flow values reflecting the annual returns times the discounting factor need to be determined and cumulated (cf. table 8.4). In this example, the net present value, at 129, would be positive, i.e. the potential investment would be worthwhile. The effects of discounting future income to its present value are substantial. For example, the return listed as 200 in item 10 would have a cash-flow value of 77 for a calculatory interest rate of 10°,to.

9.1 Determining factors of acceptance for biogas plants

On the whole, the question of acceptance covers all aspects of biogas technology discussed in this book (agriculture, engineering/ construction, operation and maintenance, economic viability). In order to avoid redundancy, this chapter is therefore limited to a discussion of general aspects that have not yet been accounted for.

Biogas extension efforts should include special consideration of the role played by women, since it is they and their children who perform much of the important work needed to keep a biogas plant running. This includes tending cattle, collecting substrate, fetching water, operating gas appliances, cooking, spreading digested slurry, etc. In many cultures, however, they are by tradition hardly directly involved in the process of decision making, e.g. the decision "biogas plant: yes/no and how". Nor are they often allowed for in connection with external project planning. In other regions, though, e.g. many parts of West Africa, women are economically independent of their husbands, i.e. they have their own fields, animals and farm-produce marketing channels.

Extension officers charged with planning and building biogas plants often have little or no awareness of the specific local and regional social conventions. Thus, the promotion of participation, the articulation of user interests, and the involvement of local extension workers are all very important for doing them at least some degree of justice.

In general, a general willingness to accept the construction and operation of biogas plants can be expected and/or can be increased by:

Planning/project organization - involving the users, especially the women, in all decisions concerning "their" biogas plant - coordinating all essential program measures with target group representatives - keeping the user/target group informed - establishing trustworthy, reliable implementing agency;

Sociocultural - existing willingness to handle feces and gas - identicality of users (beneficiaries) and operators of the respective biogas plants - positive image of biogas technology, or image polishing through biogas plants;

Engineering/construction - well-functioning, durable and good-looking plants from the very start - availability of well-functioning, inexpensive, modern gas appliances (burners, lamps, refrigerators, etc.) - user friendliness of plants and appliances - guaranteed supply of materials and spare parts and assured repair and maintenance;

Agriculture - stabling practice or tendency toward such practice - effective time savings, e.g. by direct connection of the biogas plant to the barn - willingness to use digested slurry as fertilizer, knowledge of storage and spreading techniques, and appreciation of the positive effects of fertilizing - availability of suitable, inexpensive slurry spreading implements;

Economy - reasonable expense in terms of money and work involved (as viewed from the user's standpoint) - real and, for the user, obviously positive cost-bereft ratio (not necessarily just in terms of money) - favorable financing(loans,subsidies),

Household advantages - improved working conditions in the kitchen (less smoke and flies, better appearance, modernization) - introduction or improvement of artificial lighting - effective workload reduction - complete, reliable supply of energy through biogas.

10.1 Design calculations and drawings

10.1.1 Floating-drumplants 10.1.2 Fixed-domeplants 10.1.3 Earth pit with plastic-sheet gasholder 10.1.4 Estimating the earth-pressure and hydraulic forces 10.1.1 Floating-drum plants

Design calculation

Sizing factors	Example
Daily substrate input, Sd	= 115 l/d
Retention time, RT	= 70 days
Daily gas production, G	= 2.5 m^3/d
Storage capacity,Cs	= 60%
Digester volume, Vd	= 8 m^3
Gasholder volume, Vg	= 1.5 m^3

Calculating formulae after Sasse, 1984 1. Vg = Cs G 2. ha = design-dependent 3. Vg= r p h 4. rg =

$$\sqrt{Vg / (\pi \cdot h)}$$

5. rd = r + 0.03
6. Vd1 = p d^2 p h
7. Vd2 = R^3 p 2/3
8. R =

$$\sqrt[3]{Vd2 / (\pi \cdot 2/3)}$$

9. Vd3 = R^2 p H/3
10. H = R/5
11. Vd3 = R3 p 1/15

12. Vd2 : Vd3 = 10 : 1
13. Vd(2+3) = 1.1 Vd2
14. Vd(2+3) = Vd - Vd1
15. hd = hg
16. hdk = hd + structurally dependent free board (0.1 . . . 0.2 m)

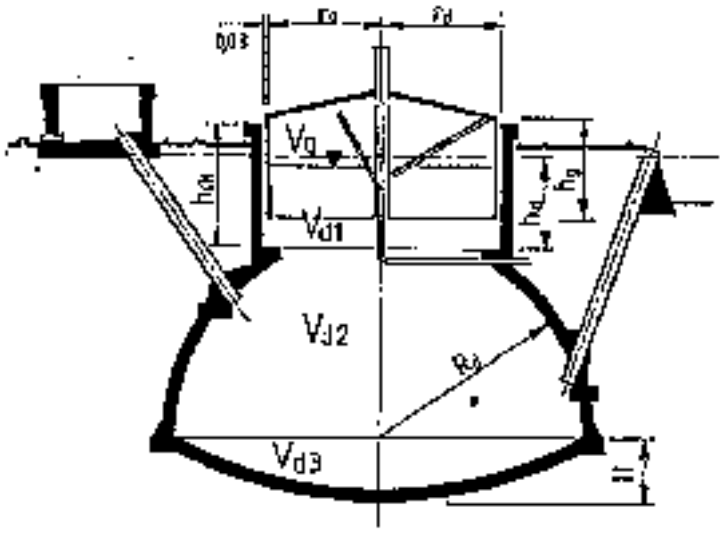


Fig. 10.1: Conceptual drawing of a floating-drum biogas plant
Vd = Vdl +Vd2 +Vd3 = digester volume Vg = gasholder volume Index g = gas holder Index d = digester

Sample calculation	**Results**
1. Vg = 0.6 ☐2.5	= 1.5 m³
hg = (specified)	= 0.7 m
4. r = $\sqrt{1.5 / 3.14 \cdot 0.7}$	= 0.82 m
5. r = 0.85 (chosen)	
6. Vdl = 0.852 ☐3.14 ☐0.7	= 1.58 m³
14. Vd (2+3) = 8.45 - 1.58	= 6.87 m³
8+ 14. R =	= 1.45 m

$\sqrt[3]{6.87/(11\cdot 3.14\cdot 2/3)}$	

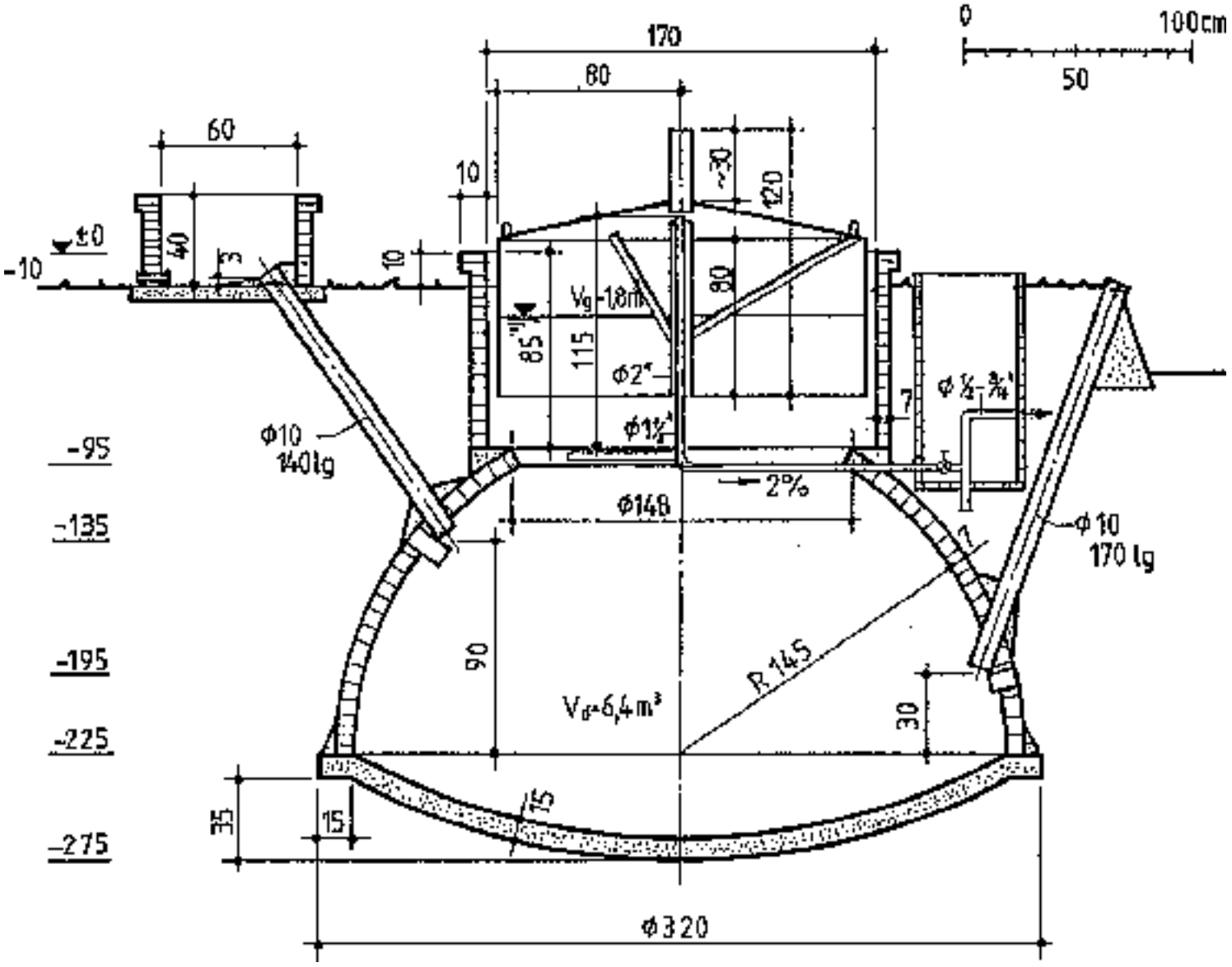
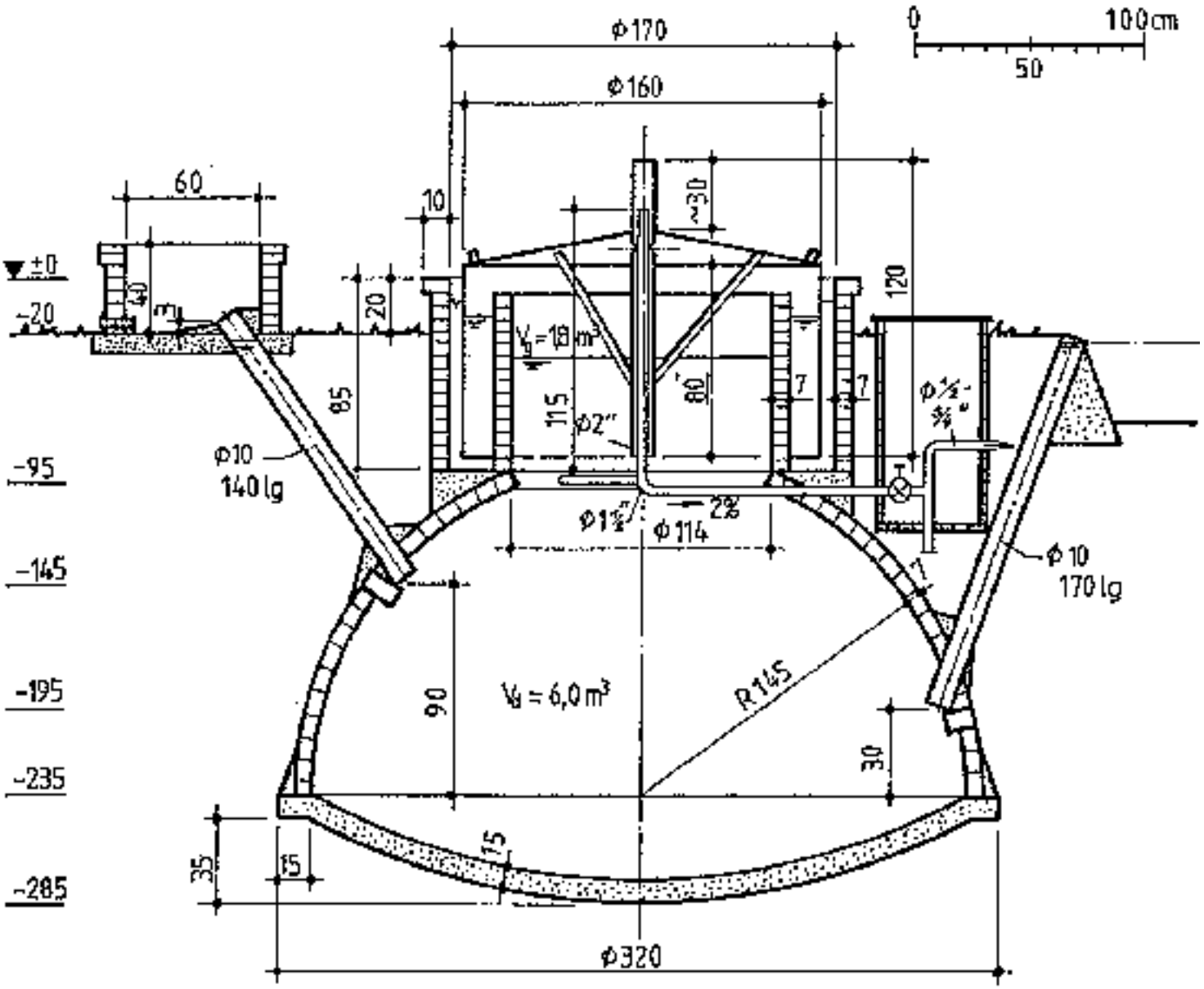


Fig. 10.2: Constructional drawing of a floating-drum plant. Vd = 6.4 m³, Vg = 1.8 m³. Material requirements: Excavation 16.0 m³, Foundation 1.6 m³, Masonry 1.1 m³, Rendered area 18.0 m², Sheet steel 5.7 m². (Source: OEKOTOP, Sasse)



10.1.4 Estimating the earth-pressure and hydraulic forces

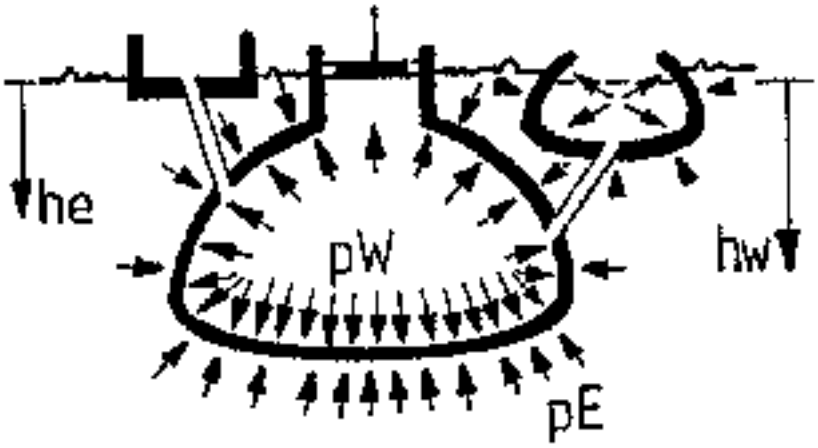


Fig. 10.8: Schematic diagram of earth-pressure and water-pressure forces
In-depth forces, h (e, w)
pW = wW hw pW = hydrostatic pressure at depth hw (m) wW = specific weight of water = 1000 kp/m³ pW = 1000 h (kp/m²) pE = wE ce he pE = active earth pressure, i.e. force of pressure of dry, previously loose but now compact column of earth on a solid vertical wall wE = specific weight of dry backfill earth = 1800 . . . 2 100 kp/m³ he = height of earth column (m) ce = coefficient of earth pressure for the earth column in question = 0.3 . . . 0.4 (-) pE = (600 . . . 700) h (kp/m²)
Force acting on a surface
P(E, W) = p A (kp = (kp/m²) m²)
Note: The above formulae are simplified and intended only for purposes of rough estimation.

10.2 Gas-law calculations

10.2.1 Calculating the pressure drop in a gas pipe 10.2.2 Calculating gas parameters 10.2.1 Calculating the pressure drop in a gas pipe

dp = FL + Ztot dp = pressure drop (N/m²) FL = friction losses in the gas pipe (N/m²) Ztot = sum total of friction losses from valves, fittings, etc. (N/m²) dp = cp l/D D/2 v2 + (cfl D/2 v2 + . . . + cfn D/2 v2) (approximation formula) cp = coefficient of pipe friction (-) l = length of pipe section (m) D = pipe diameter(m) g = density of biogas (1.2 kg/m³) v = velocity of gas in the pipe (m/s) cf = friction coefficients of valve, fittings, etc. Q = v A Q = gas flow (m³/s) v = velocity of gas in the pipe (m/s) A = p r^2 = cross-sectional area of pipe

The coefficient of pipe friction (cp = non. dimensional) is a function of: - the pipe material and internal surface roughness - pipe diameter - flow parameter (Reynolds number)

For pipe diameters in the 1/2" . . . 1" range, the coefficients of friction read: PVC tubes approx. 0.03 steel pipes approx. 0.04

Some individual friction-loss factors (cf; nondimensional)

elbow	0.5	valve 3.0
constriction	0.02-0.1	water trap 3 - 5
branch	0.8-2.0	

10.2.2 Calculating gas parameters

Temperature-dependent change of volume and density

D = DN ☐P ☐TN / (PN ☐T) V = VN ☐PN ☐T / (P ☐TN)

where: D = density of biogas (g/l) DN = density under s.t.p. conditions (0 °C, 1013 mbar) V = volume of biogas (m^3) VN = volume of biogas under s.t.p. conditions P = absolute pressure of biogas (mbar) PN = pressure under s.t.p. conditions (1013 mbar) T = absolute temperature of biogas (measured in ºKelvin = ºC + 273) TN= temperature under s.t.p. conditions (0 0ºC = 273 °K) **Table 10.2: Atmospheric pressure as a function of elevation (Source: Recknagel/Sprenger, 1982)**

Elevation (km)	0	0.5	1.0	2	3	4	6	8
Atm.pressure (mbar)	1013	955	899	795	701	616	472	365

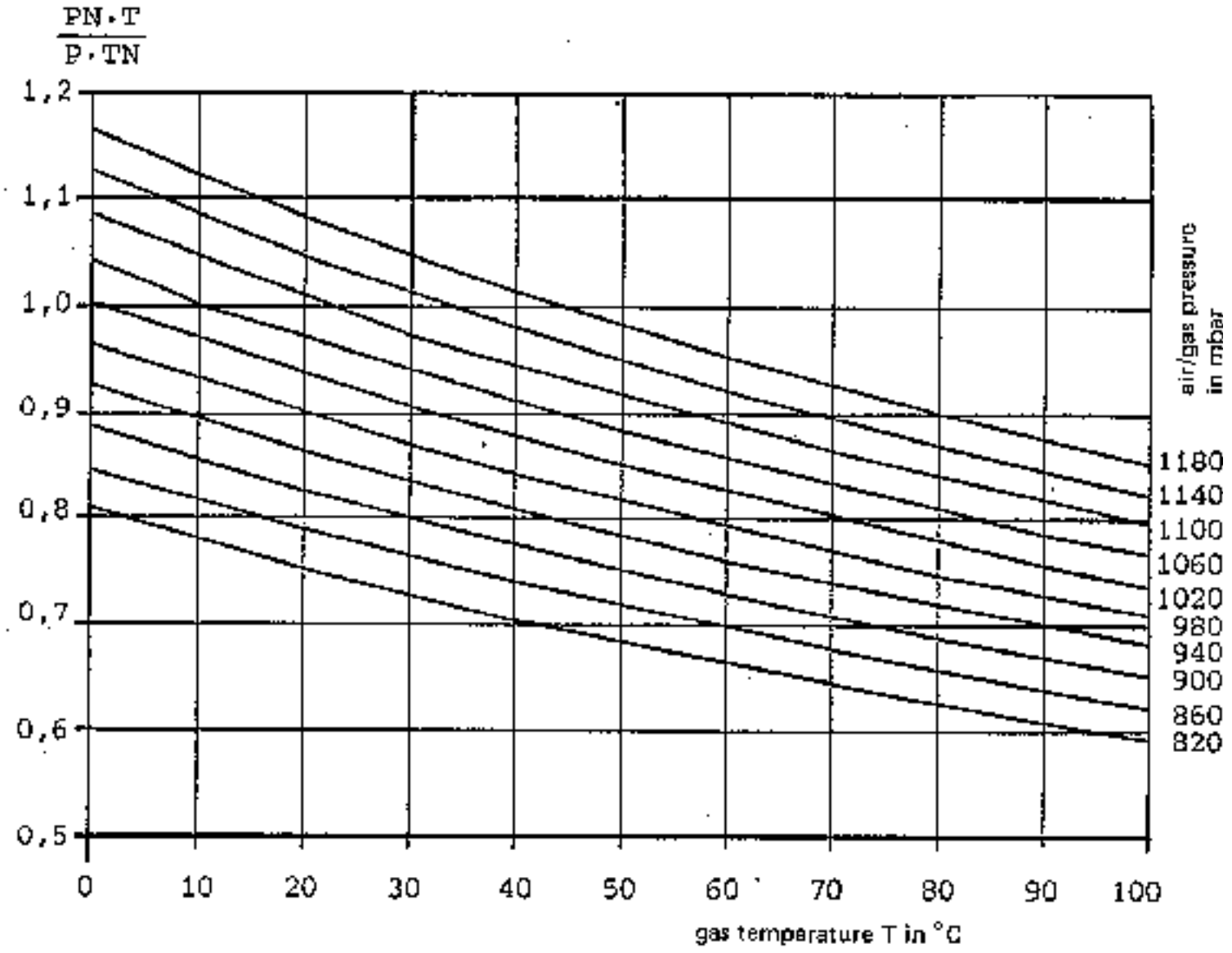


Fig. 10.9: Nomogram for correcting gas pressures/temperatures (Source: OEKOTOP)
Determining the calorific value

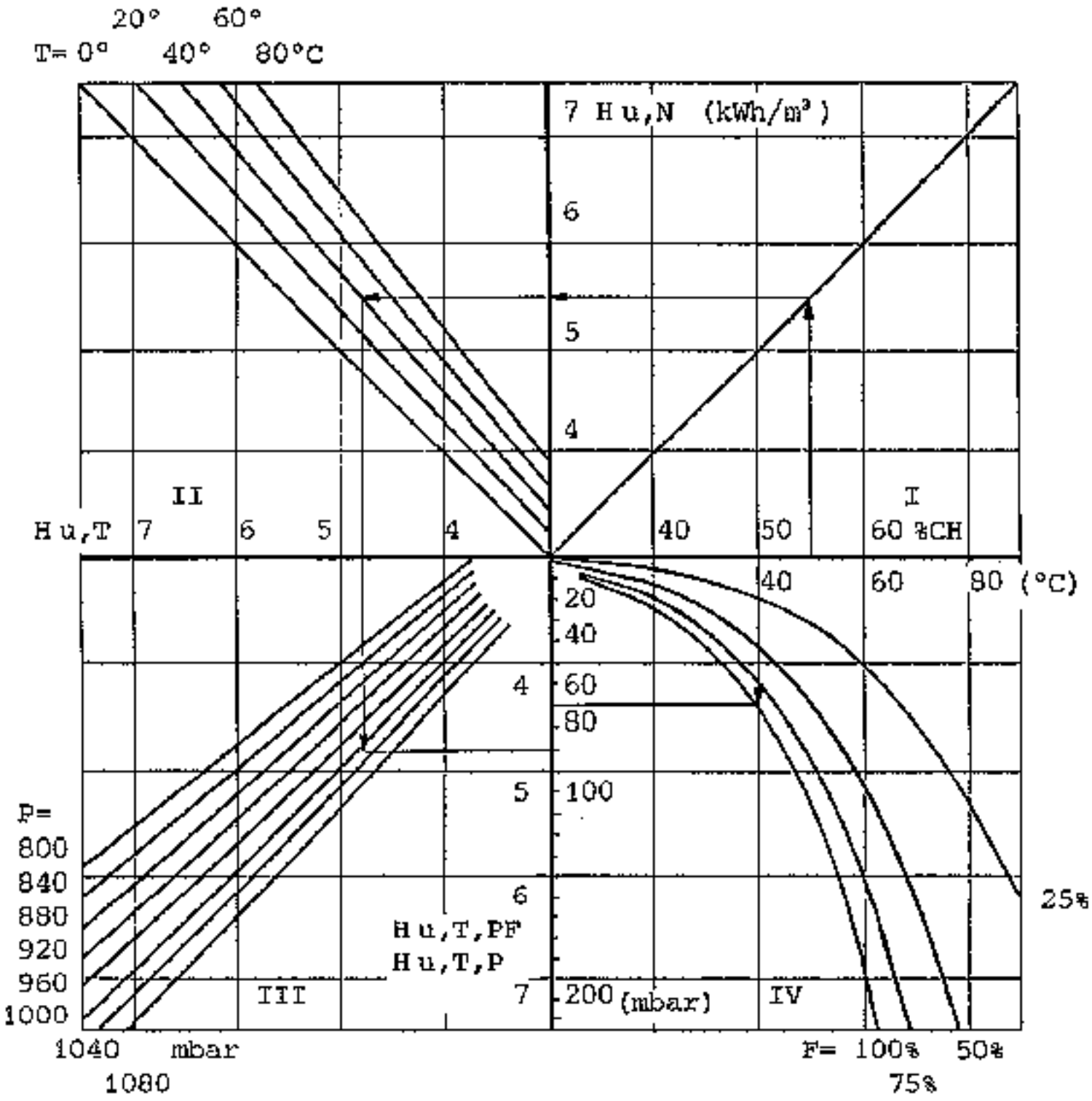


Fig. 10.10: Nomogram for finding the net calorific value of biogas as a function of temperature, pressure and moisture content. T gas temperature (°C), F relative dampness of biogas (%), Hu, N net calorific value (n.c.v.) of biogas under s.t.p. conditions (0 °C, 1013 mbar), Hu, T net calorific value (n.c.v.) at gas temperature, P gas

pressure (mbar), Hu, T, P net calorific value (n.c.v.) at gas temperature and pressure, PW partial pressure of water vapor, Hu, T, PF net calorific value (n.c.v.) of biogas at gas temperature, corrected to reflect the water-vapor fraction (Source: OEKOTOP)

Using the nomogram

1. Quadrant I: Determine the net calorific value under standard conditions as a function of the CH_4-fraction of the biogas
2. Quadrant II: Determine the net calorific value for a given gas temperature
3. Quadrant III: Determine the net calorific value as a function of absolute gas pressure (P)
4. Quadrant IV: Interim calculation for determining the partial water-vapor pressure as a function of gas temperature and relative dampness. This yields the gas pressure (PF) = absolute pressure (P) - partial pressure of water vapor (PW); PF = P - PW. The expanded calorific value determination with account for the moisture content occurs via quadrant III.

Sample calculation

Given:	
Biogas	55 vol. % CH4
Gas temperature	T = 40 °C
Gas dampness	F = 100%
Gas pressure	P = 1030 mbar

Results:		
Hu, N	= f (CH4-vol. 70)	Quadrant I
	= 5.5 kWh/m³	
Hu,T	= f(T)	QuadrantII
	= 4.8 kWh/m³	
Hu,T,P	= f(T, P)	Quadrant III
	= 4.6 kWh/m³	
PF	= f(P, T)	Quadrant IV

- f(PW)	Quadrant III	
	Hu, T, PF = 4.3 kWh/m³	

Table 10.3: Partial pressure of water vapor, PW, and absolute humidity, GM, at the saturation point (Source: Recknagel / Sprenger, 1982)

T (°C)	PW (mbar)	GM (g/m³)
.0	6.1	4.9
10	12.3	9.4
20	23.4	17.3
30	42.4	30.4
40	73.7	51.2
50	123.3	83.0
60	199.2	130.2
70	311.6	198.2
80	473.6	293.3
90	701.1	423.5
100	1013.3	597.7

10.3 Conversion tables

Table 10.4: SI units of calculation (selection) (Source: OEKOTOP, compiled from various sources)

Quantity	Symbol	Unit	Conversion
Length	1	M	1 m = 10 dm = 100 cm = 1000 mm
Area	A	m^3	1 m^3 = 100 dm^3 = 10000 cm^3
Volume	V	m^3	1 m^3 = 1000 dm^3 = 1 mill. cm^3
Mass	M	t; kg	1 t = 1000 kg
Density	D	t/m^3	1 t/m^3 = 1 kg/dm^3
Force, load	F	kN	1 kN= 1000 N ~100 kp
Stress	d	MN/m^2	1 MN/m^2 = 1 N/mm^2 ~10 kp/cm^2
Pressure	p	MN/m^2	1 MN/m^2 = 1 MPa ~10 kp/cm^2
Energy	E	kWh	1 kWh = 3.6 106 Ws ~3.6 105 kpm
Work	W	kNm	1 J = 1 Ws = 1 Nm 1 kNm ~ 100 kpm
Quantity of heat	Q	kWh	1 kWh = 3.6 X 106 Ws; 1 kcal = 4187 Ws
Power	P	kW	1 kW ~100 kpm/s = 1.36 PS
Temperature	t	°C, K	0ºK = -273 °C; 0ºC = 273 °K
Velocity	v	m/s	1 m/s= 3.6 km/in
Acceleration	b	m/s	1 m/s^2, acceleration due to gravity: 9.81 m/s^2

Table 10.5: Conversion of imperial measures (Source: Sasse, 1984)

Length	1 m = 1.094 yrd	1 yrd = 0.914 m
	1 cm = 0.0328 ft	1 ft = 30.5 cm
	1 cm = 0.394 inch	1 inch = 2.54 cm
Area	1 m^2 = 10.76 sqft	1 sqft = 0.092 m^2
	1 cm^2 = 0.155 sq.in	1 sq.in = 6.452 cm^2
	1 ha = 2.47 acre	1 acre = 0.405 ha
Volume	1 1 = 0.220 gall.	1 gall. = 4.55 1
	1 m^3 = 35.32 cbft	1 cbft = 28.31
Mass	1 kg = 2.205 lb	1 lb = 0.454 kg
Pressure	1 MN/m^2 = 2.05 lb/sqft	1 lb/sqft = 0.488 MN/m^2
	1 cm Ws = 205 lb/sqft	1 lb/sqft = 70.3 cm Ws
Quantity	1 kcal = 3.969 BTU	1 BTU = 0.252 kcal
of heat	1 kWh = 3413.3 BTU	1000 BTU = 0.293 kcal
	1 kcal/kg = 1799 BTU/lb	1 BTU/lb = 0.556 kcal/kg
Power	1 PS = 0.986 HP	1 HP = 1.014 PS
	1 kpm/s = 7.24 ft.lb/s	1 ft.lb/s = 0.138 kpm/s

Table 10.6: Conversion factors for work, energy and power (Source: Wendehorst, 1978) Comparison of work units (work = power X time)

	kpm	PSh*	Ws = J	kWh	kcal
1 kpm =	1	3.70×10^{-6}	9.807	2.7×10^{-6}	2.342×10^{-3}
1 PSh*=	270×10^{3}	1	2.648×10^{6}	0.7355	632.4
1 Ws = J =	0.102	377.7×10^{-9}	1	277.8×10^{-9}	239×10^{-6}
1 kWh =	367.1×10^{3}	1.36	3.6×10^{6}	1	860
1 kcal =	426.9	1.58×10^{-3}	4186.8	1.163×10^{-3}	1

* PS = 0.986 HP **Table 10.7: Energy content of various fuels (Source: Kaltwasser, 1980)**

Fuel	Calorific value		Unit
	MJ	kWh	
Plants	16-19	4A- 5.3	kg TS
Cow dung	18-19	5.0 - 5.3	kg TS
Chicken droppings	14-16	3.9- 4.4	kg TS
Diesel, fuel oil, gasoline	41-45	11.4-12.5	kg = 1.1 1
Hard coal (anthracite)	30-33	8.3- 9.2	kg
Wood	14-19	3.9- 5.3	kg
Producer gas	5-7	1.4 - 1.9	Nm^3
Pyrolysis gas	18-20	5.0- 5.6	Nm^3

City gas	18-20	5.0- 5.6	Nm^3
Propane	93	25.8	Nm^3
Natural gas	33-38	9.2-10.6	Nm^3
Methane	36	10.0	Nm^3
Biogas	20-25	5.6- 6.9	Nm^3

Table 10.8: Conversion factors for units of pressure (Source: Wendehorst, 1978)

	kp/m²	**N/m²**	**pa**	**cm WG**	**mbar**	**at**
kp/m²	1	10	10	0.1	0.1	0.0001
N/m²	0.1	1	1	0.01	0.01	10^{-5}
pa	0.1	1	1	0.01	0.01	10^{-5}
cm WG	10	100	100	1	1	0.001
mbar	10	100	100	1	1	0.001
at	104	105	1000	1000	1000	1

Table 10.9: Table of powers and radicals

n	**n2**	**n3**	**n**	**n2**	**n3**	**N**	**n2**	**n3**	**n**	**n2**	**n3**
0.60	0.36	0.22	1.10	1.21	1.33	1.60	2.56	4.10	2.10	4.41	9.26

0.65	0.42	0.27	1.15	1.32	1.53	1.65	2.72	4.49	2.15	4.62	9.94
0.70	0.49	0.34	1.20	1.44	1.73	1.70	2.89	4.91	2.20	4.84	10.65
0.75	0.56	0.42	1.25	1.56	1.95	1.75	3.06	5.36	2.25	5.06	11.39
0.80	0.64	0.51	1.30	1.69	2.20	1.80	3.24	5.83	2.30	5.29	12.17
0.85	0.72	0.61	1.35	1.82	2.46	1.85	3.42	6.33	2.35	5.52	12.98
0.90	0.81	0.73	1.40	1.96	2.74	1.90	3.61	6.86	2.40	5.76	13.82
0.95	0.90	0.86	1.45	2.10	3.05	1.95	3.80	7.41	2.45	6.00	14.71
1.00	1.00	1.00	1.50	2.25	3.38	2.00	4.00	8.00	2.50	6.25	15.63
1.05	1.10	1.16	1.55	2.40	3.72	2.05	4.20	8.62	2.55	6.50	16.58

n	n1/3	n	n1/3	n	n1/3	N	n1/3	n	n1/3	n	n1/3
0.001	0.10	0.22	0.60	1.33	1.10	4.10	1.60	9.26	2.10	17.58	2.60
0.003	0.15	0.27	0.65	1.53	1.15	4.49	1.65	9.94	2.15	18.61	2.65
0.008	0.20	0.34	0.70	1.73	1.20	4.91	1.70	10.65	2.20	19.68	2.70
0.016	0.25	0.42	0.75	1.95	1.25	5.36	1.75	11.39	2.25	20.80	2.75
0.027	0.30	0.51	0.80	2.20	1.30	5.83	1.80	12.17	2.30	21.95	2.80
0.043	0.35	0.61	0.85	2.46	1.35	6.33	1.85	12.98	2.35	23.15	2.85
0.064	0.40	0.73	0.90	2.74	1.40	6.86	1.90	13.82	2.40	24.39	2.90
0.091	0.45	0.86	0.95	3.05	1.45	7.41	1.95	14.71	2.45	25.67	2.95
0.125	0.50	1.00	1.00	3.38	1.50	8.00	2.00	15.63	2.50	27.0	3.00
0.166	0.55	1.16	1.05	3.72	1.55	8.62	2.05	16.58	2.55	28.37	3.05

Batch A

Document 4.6

Bylage 6: Client safety

Malaria is a prevalent disease in much of Africa, but lodges all take precautions - with a combination of mosquito nets, and sprays. Be sure to **continue the prophylactic regime** when you return home, as it is generally required up to 4 weeks after travel as well. Please see Malaria information for more details.

Yellow Fever is caused by a virus carried by a species of mosquito, and has been known to **occur in certain East African countries**. There have been no recent outbreaks, but as yellow fever is contagious, many countries require travellers to get a yellow fever inoculation. Travellers should be inoculated at least 10 days prior to travel (a certificate is issued).

The **inoculation certificate is not generally required** when entering the country in question (e.g. Kenya or Tanzania), but is required for your return to your country of residence. Please consult your Travel Clinic, or doctor, prior to travel.

Bilharzia (Schistosomiasis) is a waterborne parasite carried by snails, and **occurs in stagnant water of lakes**, dams and slow flowing rivers. However, lodges, and guides, will always caution you as to where it is safe to swim. In Africa, many lakes and rivers are home to Hippopotamus and Crocodiles anyway - so swimming is not generally recommended!

If you travel extensively in remote areas, you might also want to consult your Travel Clinic about Hepatitis A and B, and **tetanus inoculations**.

When on Safari, always ensure that you **drink sufficient quantities of water**. Day time temperatures can be extreme, even in winter, and you don't want to suffer from dehydration.

Complications from sunburn should also not be ignored - always **wear a hat with a brim**, and ensure that you carry a good supply of protection cream.

Bush **vegetation is extremely sensitive**. Off-road driving causes erosion and encourages the encroachment of unwanted plant species. Observe the animals silently and with a minimum of disturbance to their natural activities. Loud talking on game drives can frighten the animals away.

Night drives with excessive use of spotlights disrupt the activities of nocturnal animals causing temporary blindness and disorientation. **Never tease or corner wild animals**, this may cause an unpredictable response and a potentially dangerous reaction.

Do not remove any natural material from wildlife reserves. This disrupts the ecology of the area and promotes the spreading of diseases amongst domestic animals and crops. Never attempt to attract an animal's attention. **Don't imitate animal sounds**, clap your hands, pound the vehicle or throw objects.

Please **respect your driver / guide's judgment** about your proximity to certain wild animals. Don't insist that he take the vehicle closer so you can get a better photograph. A vehicle driven too close can hinder a hunt, or cause animals to abandon a hard-earned meal.

Remember that your guide is an expert, so always follow his advice and ask him questions if you are unsure of anything. Never sleep outside. **Take only photographs and memories with you**.

Litter tossed on the ground can choke or poison animals and birds and is unsightly. **Refrain from smoking on game drives**. The dry African bush ignites very easily, and a flash fire can kill many animals.

Never attempt to feed or approach any wild animal on foot. This is especially important near lodges or in campsites where animals may have become accustomed to human visitors.

Travel Documents / Money

Always have a photocopy of your passport, and any visas. Also, have a list of traveller's cheque numbers. These **copies should be packed separately** from the originals. It is never a good idea to carry large amounts of cash, and most urban centres (hotels, shops) do accept credit cards (Visa and Mastercard are most common), and traveller's cheques. You might

need cash for purchases at the local markets - keep this in a travel wallet, or a zip pocket.

Luggage

Never leave cameras and hand luggage unattended, whether in a vehicle, or even in a hotel foyer. Never pack valuables (this includes medication), in your check-in luggage.

Personal Safety

When travelling independently on your African safari, stay informed in terms of the local news. Ask at your hotel about any unsafe areas, and codes of dress and behaviour. **Don't openly carry valuables**. If you must carry your passport and money, keep them in a buttoned-down pocket.

Game Viewing

Your guide will always do a safety talk with you, whether your game viewing is to be done from a vehicle, or on foot. Wildlife is potentially dangerous, but as long as you **adhere to what you guide tells you**, there is very little to worry about. At viewpoints, hides and camps, wildlife is more familiar with people and less intimidated by your presence. Never tease or corner wild animals - this may cause an unpredictable response and a potentially dangerous reaction. Never feed any animals, as this can cause them to lose their fear of humans.

Creepy Crawlies

Although Africa is known to be home to a number of potentially dangerous species, especially snakes, scorpions, spiders, and insects, very few visitors are adversely affected. Snakes tend to be shy, and generally stay away from built-up areas. Lodges and camps generally have insect (especially mosquito) proofing in their rooms. If you go on a walk, it is always a good idea to comfortable, **enclosed walking shoes**, socks, and long trousers - just as a precaution.

Generally, there is very little to worry about when travelling in Africa. At most properties, and in most areas, the water is safe to drink, and is less chemically treated that you might imagine. In those rare cases where a property itself is concerned about water, **bottled water is always provided**. Indeed, bottled water is readily available at properties, and on safari.

Batch A

Document 4.7

GreenLine Responsible Tourism Certification Programme

Welcome:

Welcome to the GreenLine Responsible Tourism Certification Programme. By supporting GreenLine, you are showing your commitment to the development of responsible tourism across Africa. GreenLine is proudly operated by the Heritage Environmental Management Company, one of Africa's leading and most respected tourism certification initiative.

A pre questionnaire has been completed and according to the feedback we are providing you with this document containing your answers. As per the document you will notice the following;

- Green Highlighted headings – This is the category
- Red Highlighted headings – indicates the question version
- Black Highlighted headings – This indicates the Global sustainable standard question
- Black non highlighted - Compliance on sub questions
- Orange non highlighted – (N/A) The client must ensure that this is N/A according to the recommendation provided
- Red non Highlighted – (No) The client needs to make use of the provided recommendation to change the questions from a negative to a positive.

Category One

Procurement, Economic Impact and Entrepreneurial Support

Question: 1: (Mandatory question)

R1. Can the business demonstrate responsible purchasing practices, and have targets been developed for improvement in its overall purchasing practices?

Yes has been answered, sub questions are relevant.

Q1.1. Does the business have a responsible purchasing policy or procedure?

Yes

Q1.2. Does the business actively seek to purchase products and services which are environmentally friendly, recyclable or socially responsible?

Yes

Q1.3. Has the business developed targets for reduced purchasing of non-environmentally responsible products or services?

Yes

Q1.4. Can the business demonstrate support for local businesses, SMME's and fair trade practice?

Yes

Q1.5. Has the business established targets to improve the amount of purchasing it undertakes from local suppliers, SMME's and fair trade suppliers?

Yes

Question: 2: (Mandatory question)

R2. Does the business take part in any initiatives that prevents, monitors or manage the trade in endangered species, historical or archaeological products or objects?

Yes has been answered, sub questions are relevant.

Q2.1. Does the business avoid trade with any products that are sourced from any endangered species as listed by CITES (Convention on International Trade in Endangered Species) or relevant legislation?

Yes

Q2.2. Does the business have the necessary permits for the sale of items of an historical or archaeological nature?

N/A

Recommendation:

No products of a historical or archaeological nature may be sold or traded without the necessary permit or licence. Where no such licence is available, the business is in contravention of the law and all trade in the items in question must cease.

Q2.3. Does any community, historical or archaeological-related organisation benefit from the legal sale of such items?

N/A

Recommendation:

If the business does sell items from a historical or archaeological nature, the business must contribute some funds back to ensure that the process followed are maintained and properly controlled.

Q2.4. Can the business provide proof of origin of any cultural or historical objects that are sold or made available to guests or the public?

Yes

Q2.5. Does the business subscribe to the SASSI (Southern African Sustainable Seafood Initiative) in respect of seafood dishes offered for sale?

No

Recommendation:

If the business serves seafood, it must subscribe to and practice the standards of the Southern African Sustainable Seafood Initiative (SASSI) in respect of ensuring that endangered or threatened fish species are not served to guests.

Question: 3: (Mandatory question)

R3. Does the business demonstrate support for sustainable community projects or activities and community-based tourism enterprises?

Yes has been answered, sub questions are relevant.

Q3.1. Does the business actively support any local community project or activity?

Yes

Q3.2. Does the business support any community-based tourism enterprises?

Yes

Q3.3. Does the business support the development and production of local crafts and traditional products within the community?

Yes

Q3.4. Does the business encourage or make information available for guest to purchase local arts and crafts?

Yes

Q3.5. Has the business made an effort to provide guests and visitors an opportunity to purchase local arts, crafts or traditional gifts on their premises?

Yes

Category Two

Design, Construction and Development

Question: 4: (Mandatory question)

R4. Does the location and nature of the business and its facilities add to the 'sense of place' of its environment? (A 'Sense of Place', a consciousness of one's physical surroundings, is a fundamental human experience. It seems to be especially strong where a person in a neighbourhood, a community, a city, a region, possesses a collective awareness of place and express it in their cultural forms.)

Yes has been answered, sub questions are relevant.

Q4.1. Does the design and location of the buildings and facilities respect the natural or cultural heritage of its surroundings?

Yes

Q4.2. Does the design incorporate any local or traditional art, architectural or cultural elements?

Yes

Q4.3. Does the business reflect local artistic, cultural or historical elements in its decor?

Yes

Q4.4. Does the business recognise and acknowledge the intellectual property and rights of third parties in respect of its architecture, design or decor elements?

No

Recommendation:

Wherever local cultural, architectural or design elements have been used by the business, appropriate recognition must be given to the origin of the element concerned and visitors and guests must be provided with information on its origins, traditional uses, beliefs and cultural significance in an effort to ensure the protection of indigenous rights and traditions.

Q4.5. Does the business incorporate any sustainable design or construction elements?

Yes

Question: 5: (Mandatory question)

R5. Does the business provide access for persons with disabilities?

Yes has been answered, sub questions are relevant.

Q5.1. Does the business provide access ramps, lifts and other considerations for mobility impaired visitors or guests?

Yes

Q5.2. Are all passages and walkways free of obstructions and wall fixtures that could cause injury or harm to visually impaired guests?

No

Recommendation:

Passageways and walkways must be free of obstacles and any protruding fixtures to ensure that persons with visual impairments are not injured or harmed when traversing the facilities. This will

include ensuring that no fixtures on walls protrude more than 500mm from the wall and that all protruding items be no lower than 1.6 metres from the floor.

Q5.3. Does the business have facilities specifically furnished for persons with disabilities?

Yes

Q5.4. Does the business provide restroom facilities for persons with mobility impairments?

Yes

Q5.5. Does the business promote or make known the availability of such facilities?

Yes

Question: 6: (Mandatory question)

R6. Do facilities comply with all local, regional and national legislation (for changes or additions made in the past five years)?

Yes has been answered, sub questions are relevant.

Q6.1. Does the business have approved plans for any structures or facilities from the relevant authority?

Yes

Q6.2. Has the business location been zoned by the relevant authority for its current activities?

Yes

Q6.3. Is the business aware of any land claims pending against the business?

Yes

Question: 7: (Mandatory question)

R7. Are any sites of historical, social, cultural or religious significance located on the property of the business?

No has been answered, sub questions are irrelevant.

Category Three

Biodiversity Management – Fauna, Flora and Landscapes

Question: 8: (Mandatory question)

R8. Are any endangered, threatened or protected plants or wildlife consumed, traded, sold or displayed on the premises, or used in the business's activities?

Yes has been answered, sub questions are relevant.

Q8.1. Has a register of all endangered, threatened or protected species been developed by the business?

Yes

Q8.2. Does the business have relevant licences or permits from the relevant authority for endangered, threatened or protected species?

N/A

Recommendation:

Unless naturally occurring, the business must obtain a licence or permit to keep and endangered, threatened or protected species. The regional wildlife authority must be contacted.

Q8.3. Does the business take reasonable steps to protect endangered, threatened or protected species?

Yes

Q8.4. Does the business make guests and visitors aware of endangered, threatened or protected species on the property or used in the business's activities?

Yes

Question: 9: (Mandatory question)

R9. Is any wildlife held captive on the property?

No has been answered, sub questions are irrelevant.

Question: 10: (Mandatory question)

R10. Is the use of indigenous species for landscaping and restoration demonstrated by the business?

Yes has been answered, sub questions are relevant.

Q10.1. Does the business make use of indigenous water-wise species in an effort to minimise irrigation needs?

No

Recommendation:

The business must make use of indigenous plants and grasses as part of their overall landscape to reduce the demand for irrigation.

Q10.2. Has the business identified all exotic species used in the gardens and taken steps to limit their propagation and spread?

Yes

Q10.3. Has the business identified alien invasive species in the gardens?

Yes

Q10.4. Does the business have a programme in place to eradicate alien invasive species?

Yes

Question: 11: (Mandatory question)

R11. Does the business support any conservation initiative or environmental organisation?

Yes has been answered, sub questions are relevant.

Q11.1. Is this support focused on local initiatives?

Yes

Q11.3. Can the business identify specific actions undertaken by any conservation organisation or initiative which it supports?

Yes

Question: 12: (Mandatory question)

R12. Does the business minimise or avoid adverse effects on ecosystems and take steps to mitigate any negative environmental impacts resulting from its activities?

Yes has been answered, sub questions are relevant.

Q12.1. Has the business identified the environmental impacts it has?

Yes

Q12.2. Have any actions been taken to minimise or avoid environmental impacts resulting from the activities of the business?

Yes

Q12.3. Does the business avoid releasing any effluent into any natural water body?

Yes

Category Four

Communications and Marketing

Question: 13: (Mandatory question)

R13. Does promotional, marketing or publicity material issued by the business fairly and accurately describe all services or facilities offered to the public?

Yes

Question: 14: (Mandatory question)

R14. Are visitors and guests provided with adequate and appropriate information on the responsible business practices and activities undertaken by the business?

Yes has been answered, sub questions are relevant.

Q14.1. Does the business have a Responsible Business Charter?

Yes

Q14.2. Is the Responsible Business Charter made available to visitors, guests and staff?

Yes

Q14.3. Does the business provide information on its responsible business activities to visitors and guests?

Yes

Q14.4. Does the business provide information on local community-based activities and businesses?

Yes

Q14.5. Does the business compile an annual report on its responsible business and corporate social investment activities?

No

Recommendation:

The business must develop an annual reporting system on its responsible business activities and corporate social investment initiatives for interested parties. This information may be made available electronically and on request only.

Question: 15: (Mandatory question)

R15. Does the business provide a means by which visitors and guests may comment on its responsible business practice?

Yes has been answered, sub questions are relevant.

Q15.1. Are guest comments filed for corrective action?

Yes

Q15.2. Is corrective action taken based on guest comments and criticism?

Yes

Q15.3. Does the business encourage comments or criticism of its responsible business activities?

Yes

Question: 16: (Mandatory question)

R16. Does the business provide a 'Code of Behaviour' for visitors and information on the environment?

Yes has been answered, sub questions are relevant.

Q16.1. Has the Code of Behaviour been compiled in conjunction with the affected communities?

N/A

Recommendation:

When developing a Code of Practice, the business must involve the community in order to provide the necessary respect and appreciation for local customs and traditions, community structures and ensure equitable beneficiation for all.

Q16.2. Does the business provide environmental information to visitors and guests?

Yes

Q16.3. Does the information encourage guests to reduce their environmental impacts while staying at or supporting the business?

Yes

Q16.4. Does the business actively involve its staff, visitors and guests in environmentally important dates and events?

Yes

Category Five

Resource Management and Use

Question: 17: (Mandatory question)

R17. Have all reasonable steps been taken to reduce or eliminate noise and light pollution emanating from the business?

Yes has been answered, sub questions are relevant.

Q17.1. Does the business take steps to minimise noise emanating from the business?

Yes

Q17.2. Does the business take steps to ensure the minimum of light pollution emanating from the business?

Yes

Q17.3. Does the business monitor its impacts and is a complaints register made available for visitors, guests or interested parties affected by noise or light pollution?

Yes

Question: 18: (Mandatory question)

R18. Does the business demonstrate responsible water management practice?

Yes has been answered, sub questions are relevant.

Q18.1. Does the business measure and record its water consumption on a regular basis?

Yes

Q18.2. Has the business established water reduction targets and objectives?

No

Recommendation:

The business must establish and formulate water reduction targets and objectives based on actual consumption data. These targets must be achievable and realistic, taking into account national, provincial or local conditions and regulations, and the nature and style of the business.

Q18.3. Has the business installed any water-saving systems or technologies designed to reduce water consumption by the Business. E.g low-flow systems; dual flush toilets; water recycling systems; aerators and restrictors?

Yes

Q18.4. Are visitors, guests and staff encouraged to minimise their water consumption through awareness initiatives?

Yes

Q18.5. Does the business collect rain water or grey water for irrigation purposes?

No

Recommendation:

Consideration should be given to capturing rain water, runoff and or grey water for irrigation purposes as part of a water management strategy to reduce fresh water consumption.

Q18.6. Does the business have a licence for extraction of water from a borehole, river, dam or other water source and can it measure the volume of extraction?

N/A – According to country no license needed.

Question: 19: (Mandatory question)

R19. Does the business demonstrate responsible energy management practice?

Yes has been answered, sub questions are relevant.

Q19.1. Does the business measure and record its energy consumption on a regular basis?

Yes

Q19.2. Has the business established energy reduction targets and objectives?

Yes

Q19.3. Has the business installed any energy-saving systems or technologies designed to reduce energy consumption by the business?

Yes

Q19.4. Are visitors, guests and staff encouraged to minimise their energy consumption through awareness initiatives?

Yes

Q19.5. Does the business make use of any sustainable energy sources for its energy needs?

Yes

Question: 20: (Mandatory question)

R20. Does the business demonstrate responsible waste management practice?

Yes has been answered, sub questions are relevant.

Q20.1. Does the business measure and record its monthly waste streams?

No

Recommendation:

The business must record waste levels on a regular basis and the information must be collated for use. This must include all sources of waste including wet; glass; paper; cardboard; metals; plastics and hazardous waste.

Q20.2. Has the business established a recycling and recovery programme?

Yes

Q20.3. Has the business identified the ratio of recycled and recovered waste to total waste volumes?

No

Recommendation:

In order to accurately measure performance, the business must determine the ratio of waste that is being recycled or recovered. This percentage will determine the effectiveness of the waste recovery programme. It is recognised that as much as 80% of waste can be recycled and this should be the target for the business over the coming years.

Q20.4. Does the business store and dispose of hazardous waste materials in a responsible manner?

Yes

Q20.5. Are visitors, guests and staff encouraged to minimise and recycle waste through awareness initiatives?

Yes

Question: 21: (Mandatory question)

R21. Does the business take steps to actively control or improve air quality?

Yes has been answered, sub questions are relevant.

Q21.1. Has the business identified its sources of greenhouse gas emissions?

Yes

Q21.2. Does the business manage and monitor all vehicle travel on its behalf?

Yes

Q21.3. Does the business avoid the use of wood, coal or other fossil fuels for heating or cooking purposes?

No

Recommendation:

Where the use of fossil fuels for heating or food preparation is unavoidable, the business must develop a plan to reduce and replace all such heating or cooking systems over a reasonable and achievable period. As an immediate step, a strategy must be implemented to reduce and minimise the fuel sources used.

Q21.4. Does the business prevent the burning of any waste, garden refuse or other materials on the property?

No

Recommendation:

The business must ensure that no burning of waste of any kind takes place on or around the property.

Q21.5. Is the business making use of new generation refrigerants or coolants (avoiding CFC's)?

Yes

Question: 21: (Mandatory question)

R22. Has the business reduced or limited the use of harmful chemicals, pesticides, poisons and cleaning materials?

Yes has been answered, sub questions are relevant.

Q22.1. Does the business actively select environmentally friendly, bio-degradable or organic cleaning materials?

Yes

Q22.2. Does the business make use of environmentally friendly visitor or guest amenities?

Yes

Q21.3. Does the business avoid the use of wood, coal or other fossil fuels for heating or cooking purposes?

Yes

Q21.4. Does the business prevent the burning of any waste, garden refuse or other materials on the property?

Yes

Question: 22: (Mandatory question)

R22. Has the business reduced or limited the use of harmful chemicals, pesticides, poisons and cleaning materials?

Yes has been answered, sub questions are relevant.

Q22.1. Does the business actively select environmentally friendly, bio-degradable or organic cleaning materials?

Yes

Q22.2. Does the business make use of environmentally friendly visitor or guest amenities?

Yes

Q22.3. Does the business record all poisons, herbicides, weed killers, hazardous materials and other dangerous products kept on site?

Yes

Q22.4. Are all hazardous and dangerous materials and products kept in a locked facility?

Yes

Q22.5. Does the business make use or organic, environmentally responsible or bio-degradable pest control measures?

Yes

Question: 23: (Mandatory question)

R23. Has the business taken measures to minimise and avoid any environmental impacts associated with its activities?

Yes has been answered, sub questions are relevant.

Q23.1. Does the business have measures in place to manage or minimise spills or contamination of water or ground?

Yes

Q23.2. Does the business train its personnel in pollution avoidance measures?

No

Recommendation:

Staff at the business must receive training in the correct application of spill containment or neutralising materials and the treatment and disposal of contaminated materials, water or soil.

Q23.3. Does the business have a sustainability vision or plan?

Yes

Q23.4. Does the business promote the equitable sharing of all natural resources with its local community?

No

Recommendation:

The business must promote and apply equitable sharing of all natural resources available to it and its local community. At no time should the business utilise or impact any natural resource at the expense of the community at large.

Category Six

Personnel, Social and Community Development

Question: 24: (Mandatory question)

R24. Does the business provide skills training and personal development opportunities for staff?

Yes has been answered, sub questions are relevant.

Q24.1. Does the business have a skills training and development programme for its staff?

Yes

Q24.2. Does the programme include awareness and training on responsible business practice?

Yes

Q24.3. Are staff provided with any personal development opportunities by the business?

Yes

Q24.4. Does the business take steps to raise awareness of and treatment for HIV, TB for its employees and their families?

Yes

Question: 25: (Mandatory question)

R25. Does the business apply fair, legal and equitable processes for the recruitment, retention and promotion of employees?

Yes has been answered, sub questions are relevant.

Q25.1. Does the business recruit and provide promotion for employees with due regard to race, gender and disability?

Yes

Q25.2. Does the business pay its employees in accordance with the prescribed minimum wage structure relevant to its location?

Yes

Q25.3. Does the business recruit employees from the surrounding community?

Yes

Q25.4. Does the business provide promotional opportunities for historically disadvantaged individuals or groups?

Yes

Q25.5. Are any historically disadvantaged individuals in any managerial position in the business?

Yes

Question: 26: (Mandatory question)

R26. Does the business conform to all national and international conventions, treaties and laws related to labour practice, ethnicity, gender sensitivity, exploitation and child labour?

Yes has been answered, sub questions are relevant.

Q26.1. Does the business prevent the use of child labour for any activity or position in the business?

Yes

Q26.2. Does the business prevent any form of sexual exploitation by visitors, guests or staff?

Yes

Q26.3. Are employees of the business being paid in a recognised currency?

Yes

Question: 27: (Mandatory question)

R27. Does the business demonstrate support for community development and corporate social investment opportunities?

Yes has been answered, sub questions are relevant.

Q27.1. Does the business undertake any community development or corporate social investment initiatives?

Yes

Q27.2. Have the initiatives been considered and undertaken in consultation with the local community?

Yes

Q27.3. Are the CSI and Community Development initiatives of a sustainable nature?

Yes

Q27.4. Does the business offer visitors and guests the opportunity to participate in any community development or Corporate Social Initiatives with the business?

Yes

Q27.5. Are visitors and guests provided with transparent feedback on their contributions to community development or Corporate Social Initiatives by the business?

Yes

Category Seven

Management and Legal

Question: 28: (Mandatory question)

R28. Can management demonstrate its commitment to sustainable and responsible business practice?

Yes has been answered, sub questions are relevant.

Q28.1. Does the business have a sustainable business management system or programme?

Yes

Q28.2. Does the sustainable business system or programme address environmental, socio-cultural, quality, health and safety issues?

Yes

Q28.3. Does the business have an appropriate management structure to ensure sustainable and responsible business practice?

Yes

Question: 29: (Mandatory question)

R29. Does the business comply with all relevant local, provincial and National legislation, regulations, licences and/or permits as may be required?

Yes has been answered, sub questions are relevant.

Q29.1. Does the business have all necessary trading licences and permits as required by its local authority or Department of Trade and Industry?

Yes

Q29.2. Does the business have the prescribed Health Certificate issued by the local authority?

Yes

Q29.3. Does the business have adequate public indemnity insurance?

Yes

Batch A

Document 4.8

[redacted] (Safari Destinations)

Today at 9:46 AM

To: Greensafaris Cc: [redacted] honour

Re: [redacted]

Hi [redacted],

Lovely to hear from you.

In dealing with [redacted], I've noticed a growing interest in wanting to support green / eco friendly operators as a priority. Given that safaris are about the bush experience and getting back to nature, having operators who commit to reducing their environmental footprint is key to ensuring we'll still have green, unadulterated areas like Kafue to enjoy in the years to come. Ila Safari Lodge certainly fulfils a market demand for a more environmentally-conscious approach to tourism & I look forward to seeing more operators in Kafue following Ila's example with the introduction of electric vehicles and boats in future.

I hope that helps?

Cheers,

[redacted]

See More from Greensafaris

[redacted]

Bylaws & Testimonials

From: [redacted]
Subject: [redacted] - thank you!
Date: May 17, 2017 at 8:15:09 AM GMT+2
To: welcome@greensafaris.com

Hi [redacted]

Hope you are all well and that the rain has stopped by

[redacted] and I would like to thank you all so much for your hospitality and the opportunity to experience Ila for the first time.

What a wonderful stay we had, you all made us feel so welcome.

You have a beautiful lodge and we were astounded by the 'back of house' that you showed us Linda, and all that goes into making this a 'green' destination, absolutely amazing, together with your E-landy and solar powered boat.

We look forward to promoting the lodge and sending you Australian clients in the future.

Our visit to Zambia was sensational, busy as expected, but so worth it.

Thanks again!

Best wishes [redacted]

[redacted]

Von: [redacted]
Gesendet: Montag, 10. Juli 2017 19:40
An: [redacted]
Betreff: Re: Green Safaris is the Future!

Hi [redacted],

No Problem.

One of the questions we get asked most frequently by our prospective clients involves how to choose a responsible tour operator, eco lodge or hotel
Research shows that global interest in **ecotourism** (which was defined by The International Ecotourism Society as "responsible travel to natural areas that conserves the environment and improves the welfare of local people") has grown rapidly in recent years. We have noticed this at shows , and in our enquiries.
According to the Center For Responsible Travel's 2015 Travel Trends & Statistics report, around one in five consumers (21%) say they would be willing to pay more for a trip with a company that has a better environmental and social record.
A 2012 report by The Travel Foundation found that 66% of travelers surveyed would like to be able to identify a "greener" holiday more easily. And 84% of those working in travel PR/marketing see "green" credentials becoming increasingly important in the near future.
Unfortunately, these sorts of stats attract a good bit of greenwashing from profit-driven people looking to cash in on the eco-friendly movement. So how do you find a responsibly managed eco lodge when you travel?
Eco lodges and green hotels both emphasize elements such as environmental responsibility and minimizing negative impact. The best ones offer renewable energy sources, recycling services, eco-friendly toiletries, energy efficient lighting, locally sourced food, organic linens and towels, non-toxic cleaning supplies, non-disposable dishes, water conservation methods and various other sustainability-focused initiatives.
Eco lodges tend to be more dependent on the natural environment than green hotels, more active in nature and wildlife conservation, more focused on educating visitors about the flora and fauna of local ecosystems, and more deeply connected with the area's indigenous culture (whose influence is often incorporated into the lodge's decor and restaurant menu).
The best eco lodges also work to ensure positive relationships with the local people. They train and employ them at fair wages, take part in community development initiatives, offer activities that help visitors conserve and appreciate local customs, and contribute to the local economy. In this way, they reinforce the notion of ecotourism as a more sustainable long-term business model than altering or destroying habitats for quick financial gains.
An eco-friendly lodge that is working hard at being as sustainable and environmentally friendly as possible will usually be extremely excited to provide measurable statics and percentages relating to how much they have reduced their kitchen waste, water waste and other consumables.

At Pinto Africa we have visited Green Ila Safari Lodge twice since its inception. Each time we have witnessed their efforts to live up to their high standards as an Eco Lodge first hand. They are not only certified but the proof is in the pudding , be it on a guided tour of the solar system , sipping a Gin&Tonic on the Electric boat or spotting the sustainable sand bags that make up the walls. We find that for clients looking to stay at a Green Eco Lodge , Ila is an easy sell and is at the top of its league in this regard in Zambia. A high standard indeed as set by highly sort after lodges in Botswana and across Africa.

Van: [redacted]
Onderwerp: [redacted] Ila Lodge 2018 prospects
Datum: 9 augustus 2017 19:37
Aan: [redacted]

Dear [redacted]

Thank you for hosting me at Ila Lodge. After visiting Ila Safari Lodge I must share with you that this is something the KNP has definitely been waiting for. So great to finally see a 5-star venue with the quality we are accustomed to offer our clients in other parks in Zambia. We have already prepared several tours combining South Luangwa, Lower Zambezi, Vic Falls and how we will are able to add Kafue at the same levels or even better!
Also great to see that ProFlight is starting direct flights to the Kafue as well! Will they use both the Chunga and the Lufupa airstrip?

Next to the quality, we will obviously highlight the unique eco setup of Ila lodge in our clients proposals, with the eLandy and eBoat truly setting you apart. Nowhere else in Zambia are these kind of silent safaris on offer, nor in other destinations for that matter! As discussed with you already, most clients will also really appreciate a visit to your community farm as well, either on their way in/out of the park, as a separate activity, to experience first hand how you are practicing sustainable community development.
Finally, lets discuss the packages for combining 3 and 4 night stays at Ila with a 2/3 night stay at Musekese and their new Busanga camp as well sometime soon. I believe this will *be a winning combination and fruitful to all parties!*
As you know, we have a soft spot when Eco is combined with human interest, especially if the local community can benefit from this.

Looking forward to our meeting and further expanding our fruitful relationship.

Kind regards,

[redacted]
Managing Director
[redacted]