

# National Vocational Certificate Level 3 in Biogas Technology

CBT Curriculum



**National Vocational & Technical Training Commission**

5th Floor, Evacuee Trust Complex

Sector F-5/1, Islamabad

Tel: +92 51 904404

Fax: +92 51 904404

Email: info@navttc.org

**Author:**

Mr. Parakash Chandara ( Biogas Training Expert Nepal )

**Reviewed by:**

Mr. Ghazanfar Abbas ( Senior Manager Curriculum PVTC / Facilitator ) , Mr. Shoaib Asif Sipra ( Technical Manager REON Energy ) , Mr. Mian Khalid Mehmood ( Chief Engineer Energy Contractors ) , Mr. S. Taskeen Akhtar ( Consultant Alternate Energy ) , Mr. Aftab Ahmad ( Technical Manager PSDF ) , Mr. Habib ur Rahman ( Manager Betapak Organisation )

**Layout and Design by:**

Ms. Maria Arif ( Freelance Consultant )

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## Preface

This curriculum is developed for the competency based training of Biogas Technicians. The term competency is at the heart of the training reform agenda, the new system of vocational education and training. Competency refers to the ability to perform 'whole' work roles to the standard expected in employment. Job performance involves more than the performance of a well-defined set of tasks in a routine, predictable way. Human performance is more than that of a programmed robot. 'Whole' work roles means that competency encompasses not only the obvious aspects of the technical skills involved in a job but also the less obvious skills such as the ability to:

- juggle/handle a number of tasks, deal with variability, coordinate and organize work (task management skills)
- deal with contingencies, problems such as delays, break downs, tight schedules (contingency management skills)
- work within an organisation; interact with groups and individuals, follow health and safety requirements, communicate effectively (job role/environment skills)

Today's 'World of Work' has undergone radical changes. The emergence of new technologies, global markets for products and services, and international competition require economies to upgrade and enhance the skill level of their human resources. Technical and Vocational Education and Training (TVET) systems all over the world are constantly challenged by this question of how to respond to the demand of a knowledge-based economy. As TVET systems and their training programmes directly relate to the world of work in terms of quantity and quality output, the approach of TVET programmes need to focus on the acquisition of technical and non-technical skills, also referred to as employability skills.

With the release of the National Skills Strategy 2009-2013 the Pakistan government has made skills development a political priority. The framework for skills development aims to:

- Change TVET education from time-bound, curriculum-based training to flexible, competency-based training;
- Bring about a shift from supply-led training to demand-driven (outcome-based) skills development by promoting the role of industry in designing and delivering TVET.

The curriculum for **Biogas Technicians – Level 2** aims to respond to this demand. It has been developed as an outcome-based course designed to teach the employability skills needed to succeed in a high-performance work environment, as defined by labour market requirements. Given the high potential of biodigester technology in the country with approximately 5 million household

qualifying for installing domestic biodigesters, there is significantly large market in the country (*Prakash C. Ghimire, Final report on the technical study of biogas plants installed in Pakistan. SNV, December 2007*) for the qualified personnel to find a job.

## 1. Introduction

1.1 **Name of course:** The title of the course is '~~Training of Biodigester Technicians (Masons) to Construct Fixed Dome Biodigester for Running Tube-wells~~**Pumps**'. This curriculum represents plan for the term, and communicates expectations to the training participants, the local artisans. The course fulfills the following competency standards:

- a. **Standard-1:** Recall basic concepts of biogas production and benefits of biodigester technology
- b. **Standard 2:** Read and interpret drawings of fixed dome biodigesters
- c. **Standard 3:** Select suitable type and appropriate size of fixed dome biodigester and carry out basic calculations
- d. **Standard 4:** Select construction materials and construction site
- e. **Standard 5:** Construct structural component of a fixed dome biodigester
- f. **Standard 6:** Install pipeline and electro-mechanical components
- g. **Standard 7:** Perform routine operation and minor maintenance tasks
- h. **Standard 8:** Practice quality norms and ensure the compliance of quality standards while construction

1.2 **Overall objective of course:** The main objective of the course is to enhance the knowledge and develop the skills of local artisans (i) to construct quality biodigesters and (ii) to ensure continued operation of the installed facility, so that the users are benefitted for long run. This curriculum is expected to be useful for local artisans to gain employment as biodigester technician as specified by TEVTA and National Vocational and Technical Training Commission. The focus of the curriculum is on construction and after-sale-services of biodigesters to be installed in farms to run tube-wells ~~pumps~~ for irrigation. The following are specific objectives:

- To familiarize the participants on Biogas Technology, in general, and Fixed Dome Biodigesters, in particular.
- To acquaint the participants on technological aspects of fixed dome biodigester, its components and working principle.
- To build skills and enhance knowledge of the participants on construction of structural components of biodigester.
- To build skills and enhance knowledge of the participants on installing biogas-filtration devices, and end-appliances (pumps, generators, stoves, lamps etc.).
- To capacitate the participants in delivering quality services related to operation and maintenance, quality assurance, diversification of end-use applications, and users' training.

1.3 **Competencies gained after completion of course:** The learning outcomes describe what participants should know, be able to do, and value by the end of their educational program. Within this curriculum, four general dimensions of learning outcomes are commonly identified:

(a) Knowledge outcomes, pertaining to grasp of fundamental cognitive content, core concepts or questions, basic principles of inquiry, a broad history, and/or varied disciplinary techniques. (b) Skills outcomes, focussing on capacity for applying basic knowledge, analyzing and synthesizing information, assessing the value of information, communicating effectively, and collaborating. (c) Attitudes and values outcomes, encompassing affective states, personal/professional/social values, and ethical principles. (d) Behavioural outcomes, reflecting a manifestation of knowledge, skills, and attitudes as evidenced by performance, contributions, etc.

This curriculum envisages to equip the participants with required knowledge and underpinning skills in all duties and tasks of different modules formulated for local technicians (masons) to install biodigester. After the completion of the training course, the participants will be able to: (a) explain the basics of biogas generation (b) read and interpret drawings of biodigesters, (c) carry out construction works as per set quality standards, (d) instruct users for effective operation and timely repair and maintenance, and (e) advice users for optimal utilization of the products of biodigesters -biogas and bioslurry.

The following are the specific outputs expected from the training:

- The participants will acquire detailed knowledge on biogas technology, its importance and use of biogas plant-products (biogas and bioslurry)
- The participants will have hands-on ~~knowledge and skills on:~~ [skills and knowledge on:](#)
  - Reading drawings of biodigesters
  - Selection of biodigester-size, construction sites and construction materials
  - Plant lay-out, digging of pits and construction of foundation
  - Construction of digester and gas storage tank
  - Construction of Inlet and Outlet chambers
  - Laying of pipelines and installation filtration system
  - Fitting of end-use-applications (stove, lamps, pumps and generators)
  - Construction of slurry pits and importance of composting
  - Routine operation and maintenance activities
  - Quality standards on biodigester construction, operation and maintenance
- The participants will know and realise the roles and responsibilities of local technicians to install biodigester.
- The participants will be able to orient/train users for ensure effective operation and routine maintenance activities.

**1.4 Job opportunities available immediately and in the future:** The graduates of this course are expected to find employment in government agencies, bilateral and multi-lateral organisations, non-governmental organisations, private and public limited

companies, and consultancies implementing biodigester technology related initiatives in the country. Given the high potential of biodigester technology in the country with approximately 5 million household qualifying for installing domestic biodigesters, there is significantly large market in the country. (*Prakash C. Ghimire, Final report on the technical study of biogas plants installed in Pakistan. SNV, December 2007*).

**1.5 Trainee entry level:** The basic qualification for the participants to take part in this training should have: (a) basic reading and writing skill, and (b) the work experience of at least 2 years as masons. Individuals having experiences in plumbing and/or carpentry in addition to masonry works should be given preference.

The selection of trainees must be done through structured interview sessions. Preference should be given to individuals showing greatest aptitude for the occupation demonstrated in the interview sessions. The perspective trainee should be of matured age to fit physically to the work and be able to travel even in difficult circumstances. Economically deprived and marginalized people meeting the set criteria should be given preferences.

**1.6 Minimum qualification of trainer:** The trainer/facilitator should have the following minimum qualification to organize and facilitate the training as trainer.

**Basic Academic Qualification:** The basic qualification for the participants to take part in this training should have a minimum of: (a) Diploma in Associate Engineering (b) At least 10 class pass (Matric) having work experience of minimum of 2 years with Biogas Construction Companies as technical supervisor or trainer. Individuals having prior experiences in supervision of construction works should be given priority. Bachelor of Civil Engineering or Diploma in Associate Engineering AE (Civil) with at least 5 years of experience in facilitating technical training or supervision of construction works.

**Training:** Specialized training on Training of Trainers

**Skill and Competencies:** The trainer should be able to wear different hats as required to ensure effective learning while facilitating the training sessions, such as:

- Facilitator
- Lecturer/Instructor
- Designer
- Organiser
- Listener/Learner
- Interpreter/ Para-phraser
- Role Model
- Negotiator

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- Moderator
- Leader
- Observer/Monitor
- Entertainer
- Evaluator
- Problem-solver/Manipulator
- Motivator

The trainer should be able to:

- Present an effective introduction.
- State the objectives and asks expectations.
- Ask [multiple](#) questions at a variety of levels.
- Provide positive feedback.
- Respond to participant questions [positively](#).
- Follow trainer's notes/a personalized reference manual.
- Maintain eye contact.
- Project voice so that all participants can hear.
- Move about the room [through balance postures and gestures](#).
- Use audiovisuals and other methods of teaching effectively.
- Display a positive use of humor.
- Present an effective summary.
- Provide for application or practice of presentation content.
- [Strong communication skills](#).

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1.7 **Medium of Instruction i.e. language of instruction:** English/Urdu/Local Languages (Punjabi, Sindhi, Pashto, Balochi)

1.8 **Sequence of the modules:**

The participants ~~must~~ take part training ~~in either~~ all the four modules as given below ~~or chose to be trained on Module 1 and 2; or 1 and 3; or 1, 2 and 4; or 1, 3 and 4.~~

**Module 1:** Describe basics of biogas generation and installation of biodigesters

**Module 2:** Construct civil structure of fixed dome biodigester

**Module 3:** Install pipeline, appliances and electro-mechanical components

**Module 4:** Ensure effective operation and timely maintenance of biodigesters

1.9 **Timeframe of assessment:** The assessment will be carried out at the end of the training sessions using appropriate assessment methods such as oral questions, observation of on-the-job involvement, simulations, and case studies to collect factual evidences. Methodology for assessments should be designed and used to make sure that the participants are assessed properly and relevantly. A standard checklist should be developed to facilitate the assessment process. Collection of evidence is important to assess the learning outcomes. Evidences should: (a) cover core knowledge and skills that are developed throughout the program's curriculum, (b) involve multiple judgments of student performance, (c) provide information on multiple dimensions of student performance. Good evidence is also relevant, verifiable, representative or typical, cumulative, actionable, and reflectively analyzed.

1.10 **Duration:** The total duration of the training would be 192 hours divided in to:

- Theoretical Sessions: 448 hours
- Practical Sessions: 148 hours
- Total Duration: 192 hours (24 days)

## 2. Overview about the training program

Module Title and Aim	Learning Units	Theory <sup>1</sup> hours	Workplace <sup>2</sup> hours	Timeframe of modules
<p><b>Module 1:</b> Describe basics of biogas generation and installation of biodigesters</p> <p><b>Aim:</b> The overall objective of this module is to make trainees familiar with the process of biogas generation, importance of biodigesters and pre-requisites for installation of a fixed dome biodigester.</p>	<p>C1.1: Explain prerequisites for biogas generation</p> <p>C1.2: Describe types and functioning/ working of biodigesters</p> <p>C1.3: Describe benefits of biodigesters and importance of the technology in Pakistan</p> <p>C2.1: Describe the basic concepts of a drawing of an object</p> <p>C2.2: Demonstrate ability to read basic drawings</p> <p>C2.3: Demonstrate ability of interpret drawing of fixed dome biodigesters</p> <p>C2.4: Read and interpret drawings of templates, appliances, pipes and fittings and filter systems</p> <p>C3.1: Select suitable type of biodigester</p> <p>C3.2: Select suitable size of biodigester</p> <p>C3.3: Carry out basic calculations</p> <p>C3.4: Interpret the relation between HRT, quantity of feeding materials and required size of biodigester</p> <p>C4.1: Name different types of construction materials needed for constructing a fixed dome biodigester</p> <p>C4.2: Appraise quality standards of construction materials</p> <p>C4.3: Explain criteria for selection of construction site</p> <p>C4.4: Explain steps of construction of a fixed dome biodigester</p> <p><a href="#">C8.3: Describe the roles and responsibilities of a biogas technician</a></p>	16	8	24

<sup>1</sup> Learning hours in training provider premises

<sup>2</sup> Training workshop, laboratory and on-the-job workplace

<p><b>Module 2:</b> Construct Civil Structure of a fixed dome biodigester  <b>Aim:</b> The overall objective of this module is to ensure that the participants: (a) acquire hands-on-experiences on construction of different structural components of fixed dome biodigesters, (b) realise the importance of quality assurance, and practice quality norms while construction.</p>	<p>C5.1: Construct digester  C5.2: Construct gas holder and turret  C5.3: Construct manhole, outlet/ hydraulic chamber  C5.4: Construct inlet and mixing tank  C5.5: Construct slurry collection and composting pit  C8.1: Describe the importance of quality assurance  C8.2: Practice quality norms during construction  <del>C8.3: Describe the roles and responsibilities of a biogas technician</del>  C8.4: Practice occupational health and safety measures</p>	8	104	112
<p><b>Module 3:</b> Install pipeline, appliances and electro-mechanical components of a fixed dome biodigester  <b>Aim:</b> The overall objective of this module is to ensure that the participants are acquainted with the correct methods of installing pipes and biogas appliances and be familiar with different types of gas-filtration systems as well as machines (generators, pumps, induction motors etc.) to operate with biogas</p>	<p>C6.1: Install pipeline  C6.2: Install appliances  C6.3: Install gas <del>filters</del><u>filtration/purification system</u>  C6.4: <del>Operate Tube-well or generator</del> <u>Install pump and/or generator</u>  C8.1: Describe the importance of quality assurance  C8.2: Practice quality norms during <u>installation</u><del>construction</del>  <del>C8.3: Describe the roles and responsibilities of a biogas technician</del>  C8.4: Practice occupational health and safety measures</p>	4	20	24
<p><b>Module 4:</b> Ensure effective operation and timely maintenance of fixed dome biodigesters  <b>Aim:</b> The overall objective of this module is to build capacity of trainees for effective operation and timely maintenance of biodigesters to ensure sustained benefits and optimal use of biodigester products – biogas and bioslurry to enhance benefits from biodigesters.</p>	<p>C7.1: Describe routine operation activities for trouble-free functioning of biodigester  C7.2: Conduct minor repair and maintenance works  C7.3: Identify potential problems and likely solutions  C7.4: Explain methods for optimum utilization of biogas and bioslurry  C7.5: Instruct users for effective operation and maintenance of biodigester  C7.6: Ensure sustainable benefits from biodigester  <del>C8.3: Describe the roles and responsibilities</del></p>	16	16	32

	<a href="#">of a biogas technician</a> C8.4: Practice occupational health and safety measures			
	<b>Total</b>	<b>44</b>	<b>148</b>	<b>192</b>

### 3. Curriculum Contents (Teaching and Learning Guide)

#### **Module 1: Describe Basics of Biogas Generation and Installation of Biodigesters**

**Aim:** The overall objective of this module is to make trainees familiar with the process of biogas generation, importance of biodigesters and pre-requisites for installation of a fixed dome biodigester..

**Duration:** 24 hours Theory: 16 hours; Practice 8 hours

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
C1.1: Explain prerequisites for biogas generation	The participants will be able to: <ul style="list-style-type: none"> <li>- Explain methods of biogas production</li> <li>- Explain different types of inputs (feeding materials) for biodigesters</li> <li>- Explain merits and demerits of different feeding materials</li> <li>- Describe why cattle dung is the best feeding material for Pakistan context</li> <li>- Explain ideal conditions for biogas generation</li> <li>- Describe effects of temperature on biogas generation</li> </ul>	<ul style="list-style-type: none"> <li>- Basic waste-to-energy concept</li> <li>- Ideal conditions for biogas generation</li> <li>- Characteristics of biogas</li> <li>- Inputs (feeding materials) for biodigesters</li> <li>- Effect of temperature <a href="#">and other parameters like CN ratio, pH etc.</a> on biogas generation</li> </ul>	1 hour	Presentation slides, slide projector, computer, stationaries, literatures/reports, bulletins	Classroom
C1.2: Describe types and functioning/ working of biodigesters	The participants will be able to: <ul style="list-style-type: none"> <li>- Describe different types of biodigesters and their strengths and weaknesses</li> <li>- Explain components of a fixed dome biodigester and function(s) of each component</li> <li>- Explain inter-relations of different components of a fixed dome biodigester</li> <li>- Describe the criteria to select a particular model</li> </ul>	<ul style="list-style-type: none"> <li>- Types of biodigesters</li> <li>- Working principle of a biodigester</li> <li>- Model selection criteria</li> <li>- Biogas and electricity generation/ operating pumps</li> </ul>	6 hour	Presentation slides, slide projector, computer, stationaries, literatures/reports, bulletins; working biodigester	Classroom and biodigester venue

	<ul style="list-style-type: none"> <li>of fixed dome biodigesters</li> <li>- Explain suitability of fixed dome designs for electricity generation</li> </ul>				
C1.3: Describe benefits of biodigesters and importance of the technology in Pakistan	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Explain the products of a biodigester</li> <li>- Recall various end use applications of biogas</li> <li>- Recall advantages of bioslurry over FYM</li> <li>- Explain benefits of biogas at household and community level</li> <li>- Explain why biodigester technology is important for Pakistan</li> </ul>	<ul style="list-style-type: none"> <li>- Characteristics and benefits of biogas and bioslurry</li> <li>- Methods of use of biogas and application of bioslurry</li> <li>- Importance of biodigester technology in Pakistan</li> </ul>	2 hour	Presentation slides, slide projector, computer, stationaries, literatures/reports, bulletins	Class room and biodigester venue
C2.1: Describe the basic concepts of a drawing of an object	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Tell why drawing is needed</li> <li>- Describe the concept of plan, elevation and sections while preparing drawings</li> </ul>	<ul style="list-style-type: none"> <li>- Pictures vs. drawings</li> <li>- Concept of Plan, elevation, section, isometric views of drawing</li> </ul>	1 hours	Presentation slides, Slide projector, computer, objects of different shapes, models, cut-pieces of wood, drawing	Classroom
C2.2: Demonstrate ability to read basic drawings	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Explain the concept of foot-inch and meter-centimeter system of measurement</li> <li>- Demonstrate ability to distinguish different types of drawings</li> </ul>	<ul style="list-style-type: none"> <li>- FPS and MKS systems of measurements</li> <li>- Concept of Plan, elevation, section, isometric views of drawing</li> </ul>	2 hour	Presentation slides, Slide projector, computer, objects of different shapes, measuring tape, models, cut-pieces of wood, drawing	Classroom
C2.3: Demonstrate ability of interpret drawing of fixed dome biodigesters	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Describe the dimensions of various components of a fixed dome biodigesters</li> <li>- Define plan, section, isometric view, and half sectional elevation of biodigesters</li> <li>- Describe inter-relationship of various components of a biodigester</li> </ul>	<ul style="list-style-type: none"> <li>- Reading dimensions in drawing</li> <li>- Components of fixed dome biodigester</li> <li>- Inter-relation between different components</li> </ul>	2 hours	Presentation slides, Slide projector, computer, objects of different shapes, models, cut-pieces of wood, drawing	Classroom

C2.4: Read and interpret drawings of templates, appliances, pipes and fittings and filter systems	The participants will be able to: <ul style="list-style-type: none"> <li>- Read drawings of various sizes of templates</li> <li>- Read drawing of mixing devices</li> <li>- Read drawing of biogas stoves and lamps</li> <li>- Read drawings of pipes and fittings</li> <li>- <a href="#">Read drawings of filter systems</a></li> </ul>	<ul style="list-style-type: none"> <li>- Types of templates and uses</li> <li>- Types of mixing device and uses</li> <li>- Types of pipes, required fittings such as tee, elbow, nipple</li> <li>- <del>CO<sub>2</sub> scrubber</del>, H<sub>2</sub>S remover, moisture remover</li> </ul>	3+ hour	Presentation slides, Slide projector, computer, templates, appliances, pipes and fittings and filter systems with drawings.	Classroom
C3.1: Select suitable type of biodigester	The participants will be able to: <ul style="list-style-type: none"> <li>- Explain pre-requisite for the selection of biodigester type such as consideration on durability, reliability, affordability, user-friendliness for construction and operation</li> <li>- Describe suitability of different designs in specific site conditions</li> </ul>	<ul style="list-style-type: none"> <li>- Criteria for site selection, proximity to cattle shed and point of application</li> <li>- Characteristics of safer construction place</li> <li>- Soil conditions</li> </ul>	1 hour	Presentation slides, Slide projector, computer, models of biodigesters	Classroom
C3.2: Select suitable size of biodigester	The participants will be able to: <ul style="list-style-type: none"> <li>- Explain pre-requisite for the selection of biodigester size</li> <li>- Estimate the quantity of feeding materials (cattle dung) available and gas production</li> <li>- Estimate the quantity of gas required based upon end-use applications</li> <li>- Select suitable size of biodigester based upon main selection criteria</li> </ul>	<ul style="list-style-type: none"> <li>- Criteria for biodigester size selection – availability and accessibility of feeding materials (cattle dung), gas/demand requirements, gas use patterns, types of end-use applications</li> </ul>	1 hour	Presentation slides, Slide projector, computer, models of biodigesters	Classroom
C3.3: Carry out basic calculations	The participants will be able to: <ul style="list-style-type: none"> <li>- Practice addition, subtraction and multiplication of measurement units</li> </ul>	<ul style="list-style-type: none"> <li>- Basic calculations – addition, subtraction, multiplication</li> </ul>	1 hour	Presentation slides, Slide projector, computer, calculator	Classroom

	<ul style="list-style-type: none"> <li>- Calculate cost and quantity estimation of biodigesters</li> <li>- Describe the quantity of various construction materials needed for different sizes of biodigesters</li> </ul>	<ul style="list-style-type: none"> <li>and division</li> <li>- Cost of construction materials and appliances</li> <li>- Quantity of construction materials</li> </ul>			
C3.4: Interpret the relation between HRT, quantity of feeding materials and required size of biodigester	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Describe the effect of HRT on size selection</li> <li>- Explain relation between quantity of feeding and HRT</li> <li>- Select size of biodigester based upon feeding materials and estimated HRT</li> </ul>	<ul style="list-style-type: none"> <li>- Concept of HRT</li> <li>- Concept of short-circuiting of dung</li> <li>- Concept of dead volumes</li> <li>- Effect of increase or decrease in size on HRT</li> </ul>	1 hour	Presentation slides, Slide projector, computer	Classroom
C4.1: Name different types of construction materials needed for constructing a fixed dome biodigester	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- State the type of construction materials needed for construction</li> </ul>	<ul style="list-style-type: none"> <li>- Construction materials such as cement, sand, stone, brick, aggregates, MS rod, acrylic emulsion paint,</li> </ul>	1 hour	OHP, presentation slides, Computer	Classroom
C4.2: Appraise quality standards of construction materials	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Describe quality standards of bricks and stones</li> <li>- Describe quality standards of cement</li> <li>- Describe quality standards of sand</li> <li>- Describe quality standards of aggregate/gravel</li> <li>- Describe quality standards of MS rod</li> <li>- Describe quality standards of acrylic emulsion paint</li> </ul>	<ul style="list-style-type: none"> <li>- Quality standards of bricks, stones, cement, sand, aggregate, MS rod, acrylic emulsion paint</li> </ul>	1 hour	OHP, presentation slides, Computer, visual aids, Sample of construction materials, and bottle for sand test.	Classroom
C4.3: Explain criteria for selection of construction site	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Explain why biodigester should be constructed near cattle shed</li> <li>- Explain why biodigester</li> </ul>	<ul style="list-style-type: none"> <li>- Added workload if biodigester is constructed far from cattle shed</li> <li>- Effect of</li> </ul>	1 hour	OHP, presentation slides, Computer, visual aids	Classroom

	<ul style="list-style-type: none"> <li>- should be located in sunny place</li> <li>- Explain why the distance between biodigester and point of use should be as minimum as possible</li> <li>- Explain why biodigester should not be constructed too close to foundation of structures, growing trees, main trail and machines producing vibrations</li> <li>- Explain why biodigesters should not be constructed in water logging areas and slide-prone areas</li> <li>- Explain the characteristics of best site for constructing biodigesters</li> </ul>	<ul style="list-style-type: none"> <li>- temperature on biogas production</li> <li>- Effect of longer pipes on cost and on risk gas-leakage</li> <li>- Damage to biodigester due tree-roots, vibrations</li> <li>- General characteristics of best suitable site for biodigester construction</li> </ul>			
C4.4: Explain steps of construction of a fixed dome biodigester	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Describe methods of construction of different components of a fixed dome biodigester</li> <li>- Describe relative positioning of different components of a fixed dome biodigesters</li> <li>- Explain the importance of reference line</li> </ul>	<ul style="list-style-type: none"> <li>- Sequential order of biodigester construction (layout, excavation, digester, gas holder, manhole, outlet, inlet, slurry pits)</li> <li>- Methods to fix reference line</li> </ul>	2 hour	OHP, presentation slides, Computer, visual aids	Classroom

**Module 2: Construct Civil Structure of a Fixed Dome Biodigester**

**Objective of the Module:** The overall objective of this module is to ensure that the participants: (a) acquire hands-on-experiences on construction of different structural components of fixed dome biodigesters, (b) realise the importance of quality assurance, and practice quality norms while construction.

**Duration:** Total - 112 hours; Theory - 16 hours; Practice - 96 hours

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
C5.1: Construct digester	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Demonstrate methods for</li> </ul>	<ul style="list-style-type: none"> <li>- Quality standards for the construction</li> </ul>	32 hours	OHP, Presentation slides, Measuring	On-the-job training venue

	<ul style="list-style-type: none"> <li>lay out (demarcation) of biodigester</li> <li>- Supervise the excavation of pit</li> <li>- Prepare mortar</li> <li>- Prepare base of the digester and construct foundation</li> <li>- Construct digester walls</li> <li>- Fix inlet pipes</li> <li>- Plaster digester walls</li> <li>- Maintain plumb of digester wall</li> </ul>	<ul style="list-style-type: none"> <li>of digester components (correct radius, correct height, foundation, floor, walls, inlet pipes, plastering, verticality of wall, smoothness of walls)</li> </ul>		<ul style="list-style-type: none"> <li>tape, lime, construction tools and equipment, construction materials, visual aids</li> </ul>	
C5.2: Construct gas holder and turret	<ul style="list-style-type: none"> <li>The participants will be able to:</li> <li>- Prepare scaffolding and formworks for dome casting</li> <li>- Select and use proper size of templates</li> <li>- Prepare mortar and cast gas holder</li> <li>- Remove scaffolding and frameworks</li> <li>- Carry out inside plastering of gas holder</li> </ul>	<ul style="list-style-type: none"> <li>- Quality standards for the construction of gas holder (correct frameworks, correct plastering layers for gas tightness, correct height, smoothness of the surface, correct placing of gas outlet pipe)</li> </ul>	28 hours	<ul style="list-style-type: none"> <li>OHP, Presentation slides, Measuring tape, lime, construction tools and equipment, construction materials, visual aids</li> </ul>	On-the-job training venue
C5.3: Construct manhole, outlet/ hydraulic chamber	<ul style="list-style-type: none"> <li>The participants will be able to:</li> <li>- Maintain correct size of manhole</li> <li>- Construct outlet walls</li> <li>- Plaster outlet walls</li> <li>- Maintain plumb of outlet wall</li> <li>- Cast concrete cover slab for outlet and fit in place</li> </ul>	<ul style="list-style-type: none"> <li>- Quality standards of construction of manhole and outlet tank of biodigester (correct size, proper finishing and plumb, correct placing of overflow opening, correct earth-filling against the walls)</li> </ul>	20 hours	<ul style="list-style-type: none"> <li>OHP, Presentation slides, Measuring tape, lime, construction tools and equipment, construction materials, visual aids</li> </ul>	On-the-job training venue
C5.4: Construct inlet and mixing tank	<ul style="list-style-type: none"> <li>The participants will be able to:</li> <li>- Construct platform for inlet tank</li> <li>- Construct walls of inlet tank</li> <li>- Plaster inlet tank</li> <li>- Fix mixing device</li> </ul>	<ul style="list-style-type: none"> <li>- Quality standards of construction of mixing tank or inlet of biodigester (correct diameter and height, proper finishing and</li> </ul>	16 hours	<ul style="list-style-type: none"> <li>OHP, Presentation slides, Measuring tape, lime, construction tools and equipment, construction materials, visual aids</li> </ul>	On-the-job training venue

		plumb, correct placing of mixing device)			
C5.5: Construct slurry collection and composting pit	The participants will be able to: <ul style="list-style-type: none"> <li>- Select location of slurry collection and composting pit</li> <li>- Decide the size of collection and composting pits</li> <li>- Supervise excavation of pits</li> <li>- Construct walls and roof of the pits</li> </ul>	<ul style="list-style-type: none"> <li>- Quality standards of construction of slurry pits (proper positioning, suitable volume, proper drainage systems, proper covering to protect against direct sun light)</li> </ul>	8 hours	OHP, Presentation slides, Measuring tape, lime, construction tools and equipment, construction materials, visual aids	On-the-job training venue
C8.1: Describe the importance of quality assurance	The participants will be able to: <ul style="list-style-type: none"> <li>- Describe the definition of quality assurance while constructing biodigester</li> <li>- Explain why quality is needed while construction</li> <li>- Explain how quality is maintained during construction</li> </ul>	<ul style="list-style-type: none"> <li>- Quality assurance is the integral part of biodigester construction</li> <li>- Quality control framework</li> <li>- Quality control visits</li> </ul>	8 hours	OHP, Presentation slides, computer, visual aids	Classroom
C8.2: Practice quality norms during construction	The participants will be able to: <ul style="list-style-type: none"> <li>- Explain quality standards to be complied while construction</li> <li>- Comply with set quality standards while constructing biodigester</li> </ul>	<ul style="list-style-type: none"> <li>- Effect of sub-standard quality of construction on the durability and serviceability of the biodigester</li> </ul>		OHP, Presentation slides, computer, visual aids	On-the-job training venue
C8.3: Describe the roles and responsibilities of a biogas technician	The participants will be able to: <ul style="list-style-type: none"> <li>- Tell roles and responsibilities of a biogas technician while construction</li> <li>- Describe what happens if a biogas technician does not fulfil his/her responsibilities</li> </ul>	<ul style="list-style-type: none"> <li>- Roles and responsibilities of a biogas technician (mason) to install quality biodigester</li> <li>- Effect of quality works on the long term functioning of a biodigester</li> </ul>		OHP, Presentation slides, computer, visual aids	On-the-job training venue
C8.4: Practice occupational health and safety measures	The participants will be able to: <ul style="list-style-type: none"> <li>- Demonstrate proper use of personal safety gears such as helmet, dungaree, safety shoes, safety belt</li> </ul>	<ul style="list-style-type: none"> <li>- Safety precautions during construction</li> <li>- Proper use of safety tools and equipment</li> </ul>		OHP, Presentation slides, computer, visual aids	On-the-job training venue

	<ul style="list-style-type: none"> <li>- Exhibit safe use of construction tools and equipment</li> <li>- Practice safety measures at works</li> <li>- <a href="#">Training on confined space entry.</a></li> </ul>	<ul style="list-style-type: none"> <li>- Safe handling of construction tools and equipment</li> </ul>			
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**Module 3: Install pipeline, appliances and electro-mechanical components of a fixed dome biodigester**

**Aim:** The overall objective of this module is to ensure that the participants are acquainted with correct methods of installing pipes, fittings and biogas appliances and are familiar with different types of gas-filtration systems as well as machines (generators, pumps, induction motors etc.) to operate with biogas

**Duration:** Total-24 hours; Theory-4 hours; Practice-20 hours

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
C6.1: Install pipeline	The participants will be able to: <ul style="list-style-type: none"> <li>- Describe quality standard of pipes and fittings</li> <li>- Select correct size of pipes and fitting</li> <li>- Select best alignment for pipe laying</li> <li>- Join pipes using correct fitting and sealing agent</li> <li>- Protect pipeline against possible damage</li> </ul>	<ul style="list-style-type: none"> <li>- Quality standards of pipes and fittings</li> <li>- Effect of longer pipeline on cost and leakages from pipelines</li> <li>- Safety measures to protect pipe and fitting against damages</li> <li>- Use of sealing agents</li> </ul>	4 hours	OHP, presentation slides, computer, visual aids, pipes and fittings, plumbing tools and equipment.	On-the-job training venue
C6.2: Install appliances/ <a href="#">Equipments</a>	The participants will be able to: <ul style="list-style-type: none"> <li>- Name different types of biogas appliances and end use applications</li> <li>- Describe quality standards of appliances</li> <li>- Fix biogas stoves, lamps and other appliances as per users' need</li> </ul>	<ul style="list-style-type: none"> <li>- Types of biogas appliances such as biogas stoves, lamps, cookers, water-heaters</li> <li>- Methods to fix appliances properly</li> <li>- Use of sealing agents</li> <li>- <a href="#">Method to install</a></li> </ul>	4 hours	OHP, presentation slides, computer, visual aids, pipes and fittings, plumbing tools and equipment.	On-the-job training venue

		<a href="#">gas flow meter, pressure meter and temperature gauge</a>			
C6.3: Install gas <a href="#">filters/filtration/purification system</a>	The participants will be able to: <ul style="list-style-type: none"> <li>- Describe quality standards of filter system</li> <li>- <a href="#">Install CO<sub>2</sub> scrubber</a></li> <li>- Install H<sub>2</sub>S remover</li> <li>- Install moisture removal</li> <li>- Install gas flow meter</li> </ul>	<ul style="list-style-type: none"> <li>- Quality standards and methods to install filter systems (<a href="#">CO<sub>2</sub> scrubber</a>, H<sub>2</sub>S remover, moisture removal)</li> <li>- <a href="#">Method to install gas flow meter</a></li> </ul>	8 hours	OHP, presentation slides, computer, visual aids, pipes and fittings, filter system, plumbing tools and equipment.	On-the-job training venue
C6.4: Install <a href="#">Tube-well or generator/pump and/or generator</a>	The participants will be able to: <ul style="list-style-type: none"> <li>- Describe quality standards of pump/generator</li> <li>- Calculate gas demand and select suitable pump/generator size</li> <li>- Explain modifications of conventional machines to operate with biogas</li> <li>- Install pumping arrangements, generators, control systems and blowers/compressors</li> </ul>	<ul style="list-style-type: none"> <li>- Proper methods to install pump/generators</li> <li>- Calculation of gas demand for a particular engine</li> <li>- Modifications of conventional engine to operate with biogas</li> </ul>	4 hours	OHP, presentation slides, computer, visual aids, pipes and fittings, plumbing tools and equipment.	On-the-job training venue
C8.1: Describe the importance of quality assurance	The participants will be able to: <ul style="list-style-type: none"> <li>- Describe the definition of quality assurance while installing pipes, appliances and filters</li> <li>- Explain why quality is needed while installing pipes, appliances and filters</li> <li>- Explain how quality is maintained while installing pipes, appliances and filters</li> </ul>	<ul style="list-style-type: none"> <li>- Quality assurance is the integral part of installation of pipes, fittings and appliances</li> <li>- Quality control framework</li> <li>- Quality control visits</li> </ul>	4 hours	OHP, Presentation slides, computer, visual aids	Classroom
C8.2: Practice quality norms during construction	The participants will be able to: <ul style="list-style-type: none"> <li>- Explain quality standards to be complied while installing pipes, appliances</li> </ul>	<ul style="list-style-type: none"> <li>- Effect of sub-standard quality of installation on the durability and</li> </ul>		OHP, Presentation slides, computer, visual aids	On-the-job training venue

	<ul style="list-style-type: none"> <li>and filters</li> <li>- Comply with set quality standards while installing pipes, appliances and filters</li> </ul>	serviceability of the biodigester			
C8.3: Describe the roles and responsibilities of a biogas technician	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Tell roles and responsibilities of a biogas technician while installing pipes, appliances and filters</li> <li>- Describe what happens if a biogas technician does not fulfil his/her responsibilities</li> </ul>	<ul style="list-style-type: none"> <li>- Roles and responsibilities of a biogas technician (mason) to install quality biodigester</li> <li>- Effect of quality works on the long term functioning of a biodigester</li> </ul>		OHP, Presentation slides, computer, visual aids	On-the-job training venue
C8.4: Practice occupational health and safety measures	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Demonstrate proper use of personal safety gears such as helmet, dungaree, safety shoes, safety belt</li> <li>- Exhibit safe use of construction tools and equipment</li> <li>- Practice safety measures at works</li> </ul>	<ul style="list-style-type: none"> <li>- Safety precautions during the installation of pipes and appliances</li> <li>- Proper use of safety tools and equipment</li> <li>- Safe handling of construction tools and equipment</li> </ul>		OHP, Presentation slides, computer, visual aids, safety gears	On-the-job training venue

#### **Module 4: Ensure effective operation and timely maintenance of fixed dome biodigesters**

**Aim:** The overall objective of this module is to build capacity of trainees for effective operation and timely maintenance of biodigesters to ensure sustained benefits and optimal use of biodigester products – biogas and bioslurry to enhance benefits from biodigesters.

**Duration:** Total - 32 hours; Theory – 16 hours; Practice - 16 hours

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
C7.1: Describe	The participants will be able to:	- Operational	8 hours	OHP,	Classroom,

routine operation activities for trouble-free functioning of biodigester	<ul style="list-style-type: none"> <li>- Prescribe correct quantity of feeding</li> <li>- Describe the effect of under-feeding and over-feeding</li> <li>- Demonstrate efficient use of different appliances such as water drain, main valve, gas taps</li> <li>- Perform leakage testing</li> <li>- Explain dos and don'ts dos for effective functioning of biodigesters</li> </ul>	<ul style="list-style-type: none"> <li>activities such as feeding of biodigester, checking of gas leakages, regeneration of filter media</li> <li>- Potential problems and likely solutions</li> <li>- Users' training on operation and maintenance</li> </ul>		Presentation slides, computer, visual aids.	simulation
C7.2: Conduct minor repair and maintenance works	The participants will be able to: <ul style="list-style-type: none"> <li>- Demonstrate changing of washers</li> <li>- Perform greasing/oiling of gas taps</li> <li>- Perform minor repair of appliances</li> <li>- Perform repair of leaked pipeline</li> </ul>	<ul style="list-style-type: none"> <li>- Minor maintenance works such as changing of washers of valves and taps, maintaining leaking joints</li> </ul>	8 hours	OHP, Presentation slides, computer, visual aids, plumbing tools and sealing agents	Classroom, simulation
C7.3: Identify potential problems and likely solutions	The participants will be able to: <ul style="list-style-type: none"> <li>- Demonstrate the use of pH meter, pressure meter, foot pump, gas flow meter to identify potential problems</li> <li>- Carry out pressure testing to detect biogas leakages</li> <li>- Inspect the colour of bioslurry, water dung ratio, flow pattern and odour of bioslurry to assess potential problems</li> </ul>	<ul style="list-style-type: none"> <li>- Methods to use pH meter, pressure meter, foot pump, gas flow meter to identify potential problems</li> <li>- Method to carry out leakage tests</li> <li>- Characteristics of digested and undigested bioslurry</li> </ul>	4 hours	OHP, Presentation slides, computer, visual aids, pressure testing tools	Classroom, simulation
C7.4: Explain methods for optimum utilization of biogas and bioslurry	The participants will be able to: <ul style="list-style-type: none"> <li>- Describe different uses of biogas and biogas appliances</li> <li>- Identify potentials for diversification of biogas end use applications</li> <li>- Tell the effect of under-</li> </ul>	<ul style="list-style-type: none"> <li>- Diversification of end use application to optimize the use of biogas</li> <li>- Effect of surplus biogas escaping into atmosphere</li> </ul>	4 hours	OHP, Presentation slides, computer, visual aids	Classroom, simulation

	<ul style="list-style-type: none"> <li>- utilisation of biogas</li> <li>- Describe characteristics and benefits of bioslurry</li> <li>- Apply suitable methods for optimal utilisation of bioslurry</li> <li>- Describe the benefits of composting of bioslurry</li> </ul>	<ul style="list-style-type: none"> <li>- Characteristics of FYM and bioslurry</li> <li>- Advantages of bioslurry over FYM</li> <li>- Proper handling of bioslurry</li> </ul>			
C7.5: Instruct users for effective operation and maintenance of biodigester	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Inform potential problems and likely solutions to users</li> <li>- Teach users to carry out effective operation works</li> <li>- Teach users to carry out minor repair and maintenance works</li> </ul>	<ul style="list-style-type: none"> <li>- Potential problem and likely solution</li> <li>- Orientation to users</li> <li>- Need of capacity building of users for effective operation and maintenance</li> </ul>	4 hours	OHP, Presentation slides, computer, visual aids	Classroom, simulation
C7.6: Ensure sustainable benefits from biodigester	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Provide warranty to ensure long term functioning of biodigester</li> <li>- Perform timely after-sale services</li> <li>- Provide user's manual</li> </ul>	<ul style="list-style-type: none"> <li>- Warranty provisions</li> <li>- Importance of users' manual</li> <li>- Need of after-sale-services</li> </ul>	4 hours	OHP, Presentation slides, computer, visual aids, warranty card	Classroom, simulation
C8.3: Describe the roles and responsibilities of a biogas technician	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Tell roles and responsibilities of a biogas technician while operation and maintenance</li> <li>- Describe what happens if a biogas technician does not fulfil his/her responsibilities</li> </ul>	<ul style="list-style-type: none"> <li>- Roles and responsibilities of technicians to ensure effective operation and maintenance of a biodigester</li> </ul>		OHP, Presentation slides, computer, visual aids	On-the-job training venue
C8.4: Practice occupational health and safety measures	<p>The participants will be able to:</p> <ul style="list-style-type: none"> <li>- Demonstrate proper use of personal safety gears such as helmet, dongri, safety shoes, safety belt</li> <li>- Exhibit safe use of maintenance tools and equipment</li> <li>- Practice safety measures at works</li> </ul>	<ul style="list-style-type: none"> <li>- Safety precautions during the operation and maintenance</li> <li>- Proper use of safety tools and equipment</li> <li>- Safe handling of maintenance tools and</li> </ul>		OHP, Presentation slides, computer, visual aids, safety gears	On-the-job training venue

		equipment			
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#### 4. Assessment Methods

**Assessment context:** The instructors/facilitators are free to apply whatever approach they found are suitable for assessment. Every module should be assessed with objective type questions after the completion of each module. To ensure effective assessment, the methodology necessarily also involve collecting direct evidence of participant learning. Direct measures are those derived through the systematic analysis of student projects, exams, or sets of specified course assignments. As such, they can make a compelling case for the extent to which the trainees have achieved expected learning outcomes. The assessment should confirm that an individual can perform to the standard expected in the workplace as expressed in the nationally endorsed competency standards, or competency standards approved by National Vocational & Technical Training Commission of Pakistan. The requirements for this training, therefore, expect the standard of National Vocational & Technical Training Commission of Pakistan to be fulfilled.

- **Critical aspects:** The most important aspect is that the learner must be able to do/demonstrate skill to do each of the tasks of biogas technicians during on-the-job sessions. Skill evaluation methodology should be designed based on each module and test should be administered accordingly. A comprehensive module test should be conducted at the end of the training and trainees' performance should be rated according to standard grading system.
- **Assessment condition:** The assessment should be done both in the class and on-the-job training venue. Structured objective type questions, checklists for verbal questions and standard cases for discussion should be designed for conducting assessment. A checklist needs to be prepared to assess the performance during on-the-job training.

*Assessment methods are the particular techniques used to gather evidence and a means of collecting evidence and these may include:*

- direct observation, for example:
  - real work/real time activities at the workplace
  - work activities in a simulated workplace environment
- structured activities, for example:
  - simulation exercises/role-plays
  - projects
  - presentations
  - activity sheets

- questioning, for example:
  - written questions, e.g. on a computer
  - interviews
  - self-assessment
  - verbal questioning
  - questionnaires
  - oral or written examinations (applicable at higher NQF levels)
- portfolios, for example:
  - collections of work samples compiled by the candidate
  - product with supporting documentation
  - historical evidence
  - journal/log book
  - information about life experience
- review of products, for example:
  - products as a result of a project
  - work samples/products
- third party feedback, for example:
  - testimonials/reports from employers/supervisors
  - evidence of training
  - authenticated prior achievements
  - interview with employer, supervisor, peer

*Assessment Instruments* are the documented questions/assessment activities developed to support the selected assessment method/s used to collect the evidence of candidate competence and may include:

- oral and written questions
- observation/demonstration checklists
- projects, case studies, scenarios
- candidate self-assessment guides
- recognition portfolios
- workplace portfolios
- simulation activities

- definition of relevant workplace documents
  - a profile of acceptable performance measures
  - templates/proformas
  - evidence/observation checklists
  - checklists for the evaluation of work samples
- **Resources required for assessment:** Drawings, Construction tools (trowel, hammers, spirit level, measuring taps, maintenance tools (pliers, hexa-fame with blades, pipe wrenches, screw-drivers, Teflon tape) monitoring tools (pH meter, thermometer, gas analyzer, gas flow meter, pressure meter), structured questionnaires and checklists.

## 5. Assessment Framework

### *Module 1: Describe Basics of Biogas Generation and Installation of Biodigesters*

Learning Units	Theory Days/hours	Workplace Days/hours	Recommended formative assessment	Recommended Methodology	Scheduled Dates
C1.1: Explain prerequisites for biogas generation	1	-	Trainees should be asked for: <ul style="list-style-type: none"> <li>- Ideal conditions for biogas generation</li> <li>- Effects of temperature, HRT, pH, carbon/nitrogen ration, water-dung ratio on biogas production</li> <li>- Biogas generation per kg of cattle dung</li> </ul>	Knowledge test (Oral Questions, pre-training and post-training tests)	At the end of training
C1.2: Describe types and functioning/ working of biodigesters	1	5	Trainees should be asked for: <ul style="list-style-type: none"> <li>- Difference between fixed dome and floating drum biodigesters</li> <li>- Working principle of a biodigester (maximum and minimum pressure, hydraulic flow pattern, short circuiting)</li> </ul>	Knowledge test (Oral Questions, pre-training and post-training tests)	At the end of training
C1.3: Describe benefits of biodigesters and importance of the technology in Pakistan	1	1	Trainees should be asked for: <ul style="list-style-type: none"> <li>- Benefits of biodigesters at household and community levels</li> <li>- Impacts of biodigesters on health, sanitation, energy</li> </ul>	Knowledge test (Oral Questions, pre-training and post-training tests)	At the end of training

			security, environment, agricultural production - Potential of biodigesters in Pakistan		
C2.1: Describe the basic concepts of a drawing of an object	1	-	Trainees should be asked: - Why drawings are needed - What happens without drawing	Knowledge test (Oral Questions, Simulations)	At the end of training, during sessions
C2.2: Demonstrate ability to read basic drawings	1	1	Trainees should be asked: - to identify plan, section, elevation and isometric views.	Knowledge test (Oral Questions, Simulations)	During the session and at the end of training
C2.3: Demonstrate ability of interpret drawing of fixed dome biodigesters	1	1	Trainees should be asked: - to read measurements of different components of a biodigester	Knowledge test (Oral Questions, Simulations)	During the session and at the end of training
C2.4: Read and interpret drawings of templates, appliances, pipes and fittings and filter systems	1	-	Trainees should be asked to: - Tell measurements of different components of templates - Name appliances, pipes and fittings showing them the drawings - Describe different types of filters	Knowledge test (Oral Questions, Simulations)	During the session and at the end of training
C3.1: Select suitable type of biodigester	1	-	Trainees should be asked to: - Name different types of biodigesters - Select suitable type for a specific case	Knowledge test (Oral Questions, During the session and at the end of training Simulations, Case presentation)	At the end of training
C3.2: Select suitable size of biodigester	1	-	Trainees should be asked: - to calculate amount of dung required for different sizes of biodigesters - to calculate gas demand. - How will they advise others to select suitable size of	Knowledge test (Oral Questions, Simulations, Case presentation)	At the end of training

			biodigesters		
C3.3: Carry out basic calculations	1	-	<p>Trainees should be asked:</p> <ul style="list-style-type: none"> <li>- To do basic calculations – addition, subtraction, multiplication and division; especially of dimensions of biodigesters.</li> </ul>	Knowledge and Performance tests (Oral Questions, Simulations, Case presentation)	During the session and at the end of training
C3.4: Interpret the relation between HRT, quantity of feeding materials and required size of biodigester	1	-	<p>Trainees should be asked:</p> <ul style="list-style-type: none"> <li>- To define HRT</li> <li>- To describe the effect of under-feeding and over-feeding on HRT</li> <li>- To propose suitable size of biodigester for a specific case</li> </ul>	Knowledge test (Oral Questions, Case presentation)	At the end of training
C4.1: Name different types of construction materials needed for constructing a fixed dome biodigester	1	-	<p>Trainees should be asked:</p> <ul style="list-style-type: none"> <li>- to name types of construction materials needed to construct fixed dome biodigesters</li> </ul>	Knowledge test (Oral questions, Observation, Simulations)	During the session and at the end of training
C4.2: Appraise quality standards of construction materials	1	-	<p>Trainees should be asked:</p> <ul style="list-style-type: none"> <li>- To describe basic quality standards of construction materials</li> <li>- To conduct bottle test to test quality of sand</li> <li>- To conduct drop test to test quality of brick</li> <li>- To conduct abrasion test to test quality of stones</li> </ul>	Knowledge test (Oral questions, simulations)	During the session and at the end of training
C4.3: Explain criteria for selection of construction site	1	-	<p>Trainees should be asked:</p> <ul style="list-style-type: none"> <li>- to select proper site for plant construction in a given case scenario (e.g. minimum distance from cattle shed, water source and kitchen, sunny place; sufficient distance from trees, foundation of building, vibrating machines, main roads etc.)</li> </ul>	Knowledge and Performance tests (Oral Questions, Simulations, Case presentation)	During the session and at the end of training
C4.4: Explain steps of construction of a fixed dome biodigester	2	-	<p>Trainees should be asked:</p> <ul style="list-style-type: none"> <li>- to describe the extent of works while constructing structural components of a</li> </ul>	Knowledge test (Oral Questions, Simulations, Case	During the session and at the end of

			biodigester (e.g. layout, excavation, digester foundation, digester walls, gas holder, manhole, outlet, inlet, compost pits)	presentation)	training
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**Module 2: Construct Civil Structures of a Fixed Dome Biodigester**

Learning Units	Theory Days/hours	Workplace Days/hours	Recommended formative assessment	Recommended Methodology	Scheduled Dates
C5.1: Construct digester	1	31	<p>Trainees should know:</p> <ul style="list-style-type: none"> <li>- how to do layout</li> <li>- how to set a reference line</li> <li>- how to construct foundation</li> <li>- how to construct digester walls</li> <li>- how to fit inlet pipes</li> <li>- how to prepare mortar (mortar ratio) for various works</li> <li>- How to plaster walls and maintain plum of walls</li> </ul> <p>Participants should know how to construct digester following the procedures as described in the construction manual.</p>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C5.2: Construct gas holder and turret	1	27	<p>Trainees should know:</p> <ul style="list-style-type: none"> <li>- How to backfill the walls before making formwork/mould for constructing gas holder</li> <li>- How to prepare mortar mix for casting concrete</li> <li>- How to place reinforcements</li> <li>- How to cast concrete dome</li> <li>- How to remove formwork/mould</li> <li>- How to plaster inside of gas holder to ensure gas-</li> </ul>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training

			<p>tightness</p> <p>Participants should be able to demonstrate the correct procedures of dome construction as specified in the construction manual.</p>		
C5.3: Construct manhole, outlet/ hydraulic chamber	1	19	<p>Trainees should demonstrate skill:</p> <ul style="list-style-type: none"> <li>- to construct manhole of correct size</li> <li>- to construct the foundation of outlet tank</li> <li>- to construct walls of outlet tank</li> <li>- to prepare mortar of required ratio</li> <li>- to do plastering works and maintain the plumb of the walls</li> <li>- to backfill the outside of walls</li> <li>- to cast slab of correct size</li> </ul> <p>Participants should be able to demonstrate the correct procedures of outlet construction as specified in the construction manual.</p>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C5.4: Construct inlet and mixing tank	1	15	<p>Trainees should know:</p> <ul style="list-style-type: none"> <li>- how to select the location of inlet</li> <li>- how to construct foundation of inlet</li> <li>- what should be the relative positioning of inlet floor and overflow opening (at least 10 cm above)</li> <li>- how to construct walls</li> <li>- how to fit <del>mixer</del> <a href="#">mixture</a> machine</li> </ul> <p>Participants will be able to demonstrate the correct</p>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training

			procedures of inlet construction as specified in the construction manual.		
C5.5: Construct slurry collection and composting pit	1	7	<p>Trainee should be asked for:</p> <ul style="list-style-type: none"> <li>- the correct size and dimensions of a slurry pit for the given size of biodigester</li> <li>- different methods of constructing bioslurry pits (earthen lined, plastic-sheet lined, masonry walls etc.)</li> </ul> <p>Participants should be able to advise farmers on digging and constructing correct size compost pits.</p>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C8.1: Describe the importance of quality assurance	1	-	<p>Trainees should be asked about:</p> <ul style="list-style-type: none"> <li>- the importance of quality assurances while constructing a biodigester</li> <li>- effects of sub-standard works on the long-term functioning of a biodigester</li> </ul>	Knowledge test (Oral questions, case presentation)	At the end of training
C8.2: Practice quality norms during construction	-	4	<p>Trainees should be asked for:</p> <ul style="list-style-type: none"> <li>- <del>Do's and Don'ts</del> while construction</li> <li>- how to comply with the set quality standards</li> </ul>	Knowledge and Performance tests (Oral questions, observation on-the-job)	At the end of training
C8.3: Describe the roles and responsibilities of a biogas technician	1	-	<ul style="list-style-type: none"> <li>- Trainees should be able to realize their roles and responsibilities on promotion, extension, and construction</li> </ul>	Knowledge test (Oral questions, case presentation)	At the end of training
C8.4: Practice occupational health and safety measures	1	1	<ul style="list-style-type: none"> <li>- Trainee should be asked about their understanding on occupational health and safety measures</li> </ul>	Knowledge and Performance tests (Oral questions, observation on-	During on-the-job sessions and at the end of

			<ul style="list-style-type: none"> <li>during construction</li> <li>- Trainee should be observed whether he/she has practiced occupational health and safety measures</li> </ul>	the-job)	training
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### Module 3: Install pipeline, fitting, appliances and electro-mechanical components

Learning Units	Theory Days/hours	Workplace Days/hours	Recommended formative assessment	Recommended Methodology	Scheduled Dates
C6.1: Install pipeline	1	3	<ul style="list-style-type: none"> <li>- Trainees should be able to tell and demonstrate the correct procedures of pipeline fitting, e.g. with minimum joints, using proper sealing agents, shortest alignment, correct sizes.</li> </ul>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C6.2: Install appliances/ <a href="#">equipments</a>	0.5	3.5	<ul style="list-style-type: none"> <li>- Trainees should be able to tell and demonstrate the correct procedures of fitting of appliances as per the user's need.</li> </ul>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C6.3: Install gas <a href="#">filtration/purification system</a>	1	7	<p>Trainee should be asked:</p> <ul style="list-style-type: none"> <li>- Why filters are needed</li> <li>- What types of filters are needed (<a href="#">CO<sub>2</sub> scrubber</a>, H<sub>2</sub>S filter, moisture remover)</li> <li>- How to install these filters, eg. with proper filter media, proper sequence, ease in regenerating filter media etc.</li> </ul>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C6.4: Install pump and/or generator	0.5	3.5	<p>The participants should demonstrate skill to:</p> <ul style="list-style-type: none"> <li>- Select correct location of pump/ generator</li> <li>- Install pump/ generator correctly</li> </ul>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C8.1: Describe the importance of quality assurance	0.5	-	<p>Trainees should be asked about:</p> <ul style="list-style-type: none"> <li>- the importance of quality</li> </ul>	Knowledge test (Oral questions, case presentation)	At the end of training

			<ul style="list-style-type: none"> <li>assurances while installing pipelines, appliances and filters</li> <li>effects of sub-standard works on the long-term functioning of a biodigester</li> </ul>		
C8.2: Practice quality norms while installing pipeline, appliances and filtration systems	-	2	<ul style="list-style-type: none"> <li>Trainees should be asked for: <ul style="list-style-type: none"> <li>Do <del>and</del> not <del>do</del> while installing pipelines, appliances and filters</li> <li>how to comply with the set quality standards while installing pipelines, appliances and filters</li> </ul> </li> </ul>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C8.3: Describe the roles and responsibilities of a biogas technician	0.5	-	<ul style="list-style-type: none"> <li>Trainees should be able to realize their roles and responsibilities on installing pipelines, appliances and filters</li> </ul>	Knowledge test (Oral questions, case presentation)	At the end of training
C8.4: Practice occupational health and safety measures	-	1	<ul style="list-style-type: none"> <li>Trainee should be asked about their understanding on occupational health and safety measures during installing pipeline, appliances and filters</li> <li>Trainee should be observed whether he/she has practiced occupational health and safety measures</li> </ul>	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training

**Module 4: Ensure Effective Operation and Timely Maintenance of a Fixed Dome Biodigester**

Learning Units	Theory Days/hours	Workplace Days/hours	Recommended formative assessment	Recommended Methodology	Scheduled Dates
C7.1: Describe routine operation activities for trouble-free functioning of biodigester	4	4	<ul style="list-style-type: none"> <li>Trainees should be asked for: <ul style="list-style-type: none"> <li>Required quality of feeding for a given size of biodigester</li> <li>Water-dung ratio</li> <li>Characteristics of proper feeding and effect of</li> </ul> </li> </ul>	Knowledge and Performance tests (Oral questions, case presentation, observation on-the-job)	During on-the-job sessions and at the end of training

			<p>improper feeding on functioning of biodigester</p> <ul style="list-style-type: none"> <li>- Routine operational activities and frequencies (feeding, testing of gas leakages regenerating filter media, use of gas control valves, proper use of appliances, oiling and greasing of movable parts, breaking of scum layers etc.)</li> </ul> <p>Participants should be able to realize the importance of proper O&amp;M</p>		
C7.2: Conduct minor repair and maintenance works	4	4	<p>Trainee should be asked for:</p> <ul style="list-style-type: none"> <li>- Demonstrating skill to carry out minor maintenance works such changing of washers, repairing of valves, repair/ changing of mixture machine, repair of appliances</li> </ul>	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During on-the-job sessions and at the end of training
C7.3: Identify potential problems and likely solutions	2	2	<p>Trainee should be asked for:</p> <ul style="list-style-type: none"> <li>- Using of different tools and equipment to monitor functioning of a biodigester (pH meter, thermometer, gas analyser)</li> <li>- Identifying problems by observing slurry colour, odour, consistency, flow pattern etc.</li> <li>- Describing most common problems and suitable solutions</li> </ul>	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During on-the-job sessions and at the end of training
C7.4: Explain methods for optimum utilization of biogas and bioslurry	2	2	<p>Trainee should be asked for:</p> <ul style="list-style-type: none"> <li>- Points to be considered for optimal utilization of biogas (diversification of end-use applications, adjustment of air flow to appliances for full</li> </ul>	Knowledge and Performance tests (Oral questions, case presentation observation on-	During on-the-job sessions and at the end of training

			combustion of biogas, use of valves and pressure meters etc.) - Different methods for application of bioslurry (composting, draining with irrigation water, wet-application, trenching etc.)	the-job)	
C7.5: Instruct users for effective operation and maintenance of biodigester	2	2	- Trainee should be asked to demonstrate his/her facilitation skill by giving a case scenario or simulate a users' training	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During simulation and at the end of training
C7.6: Ensure sustainable benefits from biodigester	2	2	- Trainees should be asked for ways to ensure sustainable benefits from a biodigester (effective operation, timely maintenance, proper use of biogas and bioslurry etc.)	Knowledge test (Oral questions, case presentation observation on-the-job)	During simulation and at the end of training
C8.3: Describe the roles and responsibilities of a biogas technician			- Trainees should be able to realize their roles and responsibilities to ensure effective operation and timely maintenance of a biodigester	Knowledge test (Oral questions, case presentation)	At the end of training
C8.4: Practice occupational health and safety measures			- Trainee should be asked about their understanding on occupational health and safety measures during conducting operation and maintenance activities - Trainee should be observed whether he/she has practiced occupational health and safety measures	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During simulation and at the end of training

## 6. List of Tools, Machinery & Equipment

<b>Name of Trade</b>	Training of Biodigester Technicians (Masons) to Construct fixed dome
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Duration		Biodigesters for Running <a href="#">Tube-wellsPumps</a>
Duration		Four weeks ( <del>36 days</del> or 288 hours)
Sr. No.	Name of Item/ Equipment / Tools	Quantity
<b>Training Equipment</b>		
1.	Computer	1
2.	Over-head Projector with screen	1
3.	White/ <del>Black</del> board	1
4.	Model/prototype of biodigester	1
5.	Flip chart board and paper	1
6.	Camera/ <a href="#">Mobile camera</a>	1
7.	Construction video/DVD	1
8.	Calculators	1
<b>Masonry Tools</b>		
9.	Measuring tape – 5m and 30m length	5 <a href="#">each</a>
10.	Plumb-bob	5
11.	Water level	<del>5</del>
12.	Mason's Trowel	25
13.	Plastering trowel- 2 types	5
14.	Pointing trowel	5
15.	Pick axe with handle	5
16.	Wheel barrow	2
17.	Chisel sets – 9" and 12"	5 <a href="#">each</a>
18.	Mason's hammer	5 <a href="#">each</a>
19.	Hammer – 1.5 kg and 3 kg	5 <a href="#">each</a>
20.	Templates (different sizes according to size of biodigester)	<del>12</del>
21.	Straight Edge (4 ft long), metal or wooden	5
22.	Level pipe (transparent plastic)	2
23.	String/thread roll	5
24.	Lime for layout	5 kg
25.	Iron trough/mortar pan – GI 18" dia (for handling concrete, mortar)	10
26.	Line and pins	LS
27.	Spirit level	3
28.	Brushes (wire brush, painting brush)	5 <a href="#">each</a> 40
29.	Shovel with handle	5
30.	Builders square	5
31.	Striker for horizontal and vertical joints	5
32.	Steel float – small, medium and large	5
33.	Wooden float – small, medium and large	5

34.	Mason's Tool bag	25
	<b>Plumbing tools</b>	
35.	Hexa-frame and blade sets	5
36.	Pipe wrench – 9" and 12"	2 <a href="#">each</a>
37.	Plier/slide wrench	2
38.	Spanners	2
39.	Needle file	2
40.	Dice and vice set	1
	<b>Personal Protective equipment</b>	
41.	Helmet	25
42.	Dungaree (Working Dress)	25
43.	Safety belt	25
44.	Boots	25
45.	Gloves	25
46.	Rain coats	25
	<b>Biogas Related Appliances/Equipment</b>	
47.	Pressure meter	1
48.	*Biogas analyser	1
49.	pH meter	1
50.	Thermometer with probes	1
51.	Foot or hand pump	1

- [One with each organization. Require during commissioning of biogas plants.](#)

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## 7. List of Consumable Supplies

<b>Name of Trade</b>	Training of Biodigester Technicians (Masons) to Construct Fixed dome Biodigesters for Running Pumps	
<b>Duration</b>	Four weeks ( <a href="#">24 days or 192 hours</a> )	
<b>Sr. No.</b>	<b>Name of Consumable Supplies (for a group of 25 participants)</b>	<b>Quantity</b>
	<b>Stationaries</b>	
1.	Flip chart paper	
2.	Meta cards – different colours	
3.	Marker pens (Permanent and board marker)	
4.	Masking tape (rolls)	
5.	Cello tape	
6.	Lime or marking powder	

7.	Biodigester drawing	
8.	Construction manuals	
9.	Operation manual	
10.	Ball pen	
11.	Pencils	
12.	Erasers	
13.	Writing pad/note book	
14.	Glue stick	
15.	Brochures of biodigester technology	
16.	Plastic bag	
17.	PlainWhite paper (A4)	
	<b>Construction Materials and appliances for 20 m<sup>3</sup> <u>fixed domefloating-drum</u> biodigester</b>	
18.	Cement	
19.	Bricks	
20.	Sand	
21.	Aggregates 20mm	
22.	Inlet pipes PVC 110 mm diameter 3 m long	
23.	MS Rod 10 mm diameter	
24.	Binding wire	
25.	Gas storage drum	
26.	Angle Iron for Guiding frames	
27.	Scaffolding	
28.	PVC/GI pipe and fittings as per site condition	
29.	Biogas filters (CO <sub>2</sub> scrubber, H <sub>2</sub> S remover, moisture remover)	
30.	Biogas appliances (as per sit condition and users' need)	
31.	Control valves – as per site condition	
32.	Main gas pipe – GI 1.5” diameter, 1 m long with reducing elbow	
33.	Teflon tape	
34.	Pressure meter	

## 8. Worker Traits and Related Knowledge

### Traits:

- Physically fit/healthy
- Sincere
- Interactive
- Good listener
- Able to work under pressure and difficult circumstances

- Polite
- Cooperative
- Dedicated
- Working with humility
- Intuitive and creative
- Motivating
- Team-spirit
- Trustworthy
- Good communicator
- Influencing
- Hard working
- Out-spoken
- Helpful
- Friendly
- Proactive/ active

**Related Knowledge:**

- Basic principle of biogas generation
- Types and functioning of a biodigester
- Measurement, Units of measurements
- Basic mathematics/calculations
- Drawing reading an interpretation
- Masonry works/ construction methods
- Plumbing works
- Operation and functions of different biogas appliances
- Quality standards of construction materials and appliances
- Use of biogas
- Application of bioslurry
- Routine Operational activities
- Minor repair and maintenance of biodigester
- Potential problems and likely solution
- Gas filtering mechanisms
- Effective communication
- [Loyal](#)
- [Efficient](#)

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This curriculum is developed by Mr. Prakash C. Ghimire ([prakashchgh@gmail.com](mailto:prakashchgh@gmail.com)) for TVET Support Reform Programme of Pakistan with a view to receive official approval from National Vocational & Technical Training Commission of Pakistan in August 2014.

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## National Vocational & Technical Training Commission (NAVTTTC)

5th Floor Evacuee Trust Complex Sector F-5/1,  
Islamabad.

T +92 51 904404

F +92 51 904404

E [info@navttc.org](mailto:info@navttc.org)

I <http://www.navttc.org/>

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