

TRAINING PROGRAMME FOR ETP OPERATORS IN TEXTILE INDUSTRY

Promotion of Sustainability in the Textile and Garment Industry in Asia - FABRIC

Sludge management units and equipment

GIZ FABRIC – ETP Operator Course



Contents

- Overview of units and equipment
- Sludge pumps
- Sludge thickening systems
- Sludge dewatering systems

Overview of units and equipment

Common units in sludge management

- Sludge pumps and conditioning units
- Sludge thickeners
- Sludge volume reducing systems including digestors
- Sludge dewatering
- Sludge driers (thermal/natural)
- Sludge disposal/utilisation systems



Sludge pumps and conditioning units

Sludge pumps and conditioning units

Designed to handle high solids content (1-7%)

Types of pumps

- **Centrifugal** pumps with open/semi open impellers
- **Submersible** pumps
 - For low solids content (e.g. thickener feed pump) and low pressure requirements
- Archimedean **screw type** pumps:
 - Designed to handle huge quantities
 - Not popular in small-medium ETPs
 - Not suitable for thick sludge



Sludge pumps and conditioning units

Types of pumps

- Progressive **cavity pumps** or ‘screw pumps’
 - Most common unit
- Air-operated **diaphragm pumps**:
 - Simple and comparatively cheaper
 - Need compressed air
 - Suitable for ETP with large pneumatic systems
- **Rotary lobe** pumps
 - Similar to air blowers used to pump thick sludge



Sludge pumps and conditioning units

Pumps for liquid sludge: Centrifugal

- Mainly for **low density sludge** from clarifier underflows and watery sludge settled in tanks
- Also for pumping **thickened sludge** (bio-sludge)
 - Good for high quantity pumping with moderate amount of **sludge consistency (1 - 4%)**
- With non-clog feature as open or semi open configuration
 - Open/semi open impellers reducing pumping rate



Sludge pumps and conditioning units

Pumps for liquid sludge: Centrifugal

- Usually with anti-abrasive materials/coating inside
- Good for medium head (10 - 40 m, 1 - 4 bars)
 - Clarifier underflow to thickener



Sludge pumps and conditioning units

Pumps for liquid sludge: Submersible

- Only for **low density sludge** such as in clarifier underflows and sludge settled in tanks
- Suitable for pumping **thickened sludge** for bio-sludge
 - Good for high quantity pumping with moderate amount of sludge consistency (**1 - 4%**)
- Equipped with cutter/grinder mechanism to prevent clogging
- Impellers made in stainless steel and pump casing in iron



Sludge pumps and conditioning units

Pumps for liquid sludge: Submersible

- Mostly **water cooled**
 - **Minimum level** to avoid loss of storage volume
- Commonly installed in **pumping chamber** within sludge storage tank
- **Not practical** for **small ETPs**
 - 10 or 20 m³ capacity for sludge tank needed
- Water flushing arrangements to clear dried sludge blockages
- Good for medium head (10 - 40 m, 1 - 4 bars)
 - Clarifier underflow to thickener



Sludge pumps and conditioning units

Pumps for liquid sludge: Progressive cavity pumps

- Most common pumping unit
 - Also called screw or helical rotor pumps
- Rotor and stator creating moving chambers to with fluid draw into and coming out with force
- Material:
 - Rotor: Stainless steel
 - Stator: EPDM rubber.



Sludge pumps and conditioning units

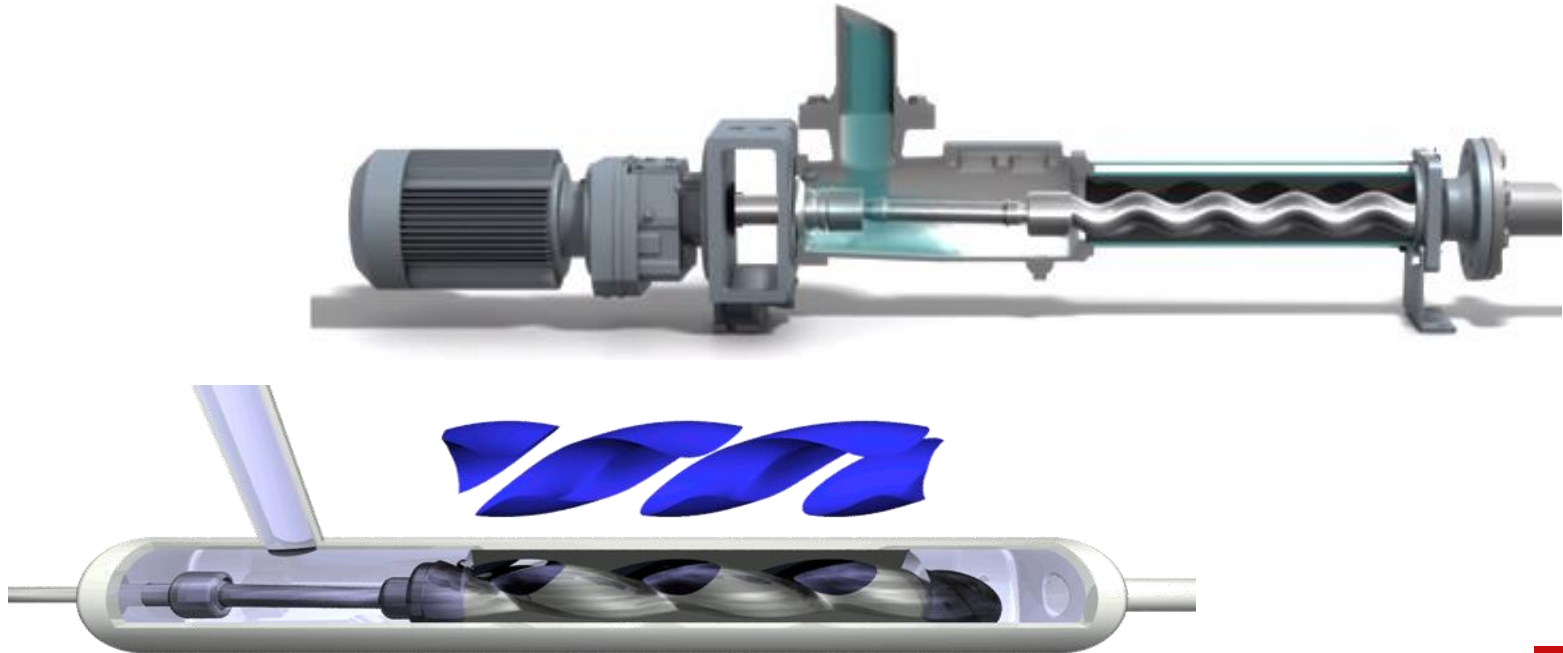
Pumps for liquid sludge: Progressive cavity pumps

- Used for **filter press feeding** (7 - 16 bar)
- Efficiency increasing with higher liquid thickness
- Output flow control by increasing or decreasing speed
- Motors controlled by Variable Frequency Drive (VFD)



Sludge pumps and conditioning units

Pumps for liquid sludge: Progressive cavity pumps



Sludge pumps and conditioning units

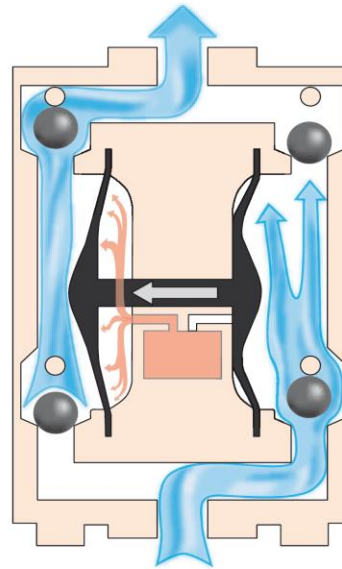
Pumps for liquid sludge: Air operated diaphragm pumps

- Positive displacement pump
 - Two pumping chambers alternately filled and discharged by flexible diaphragms movement
 - Compressed air filled and vented from two air chambers on opposite sides to create pumping action
- Diaphragm pumps leak-free with less maintenance and moving parts
 - General maintenance only for periodical replacement of diaphragms



Sludge pumps and conditioning units

Pumps for liquid sludge: Air operated diaphragm pumps



Sludge pumps and conditioning units

Pumps for liquid sludge: Air operated diaphragm pumps

- Suitable for handling **abrasive and concentrated sludges**
- No damage when running dry
- **Requiring compressed air** usually for lower pressure (up to 8 bar)
- Not suitable for filter presses for textile sludge (requiring 12 - 16 bar pressure)
- Noisy



Sludge thickening systems

Sludge thickening

Gravity thickener

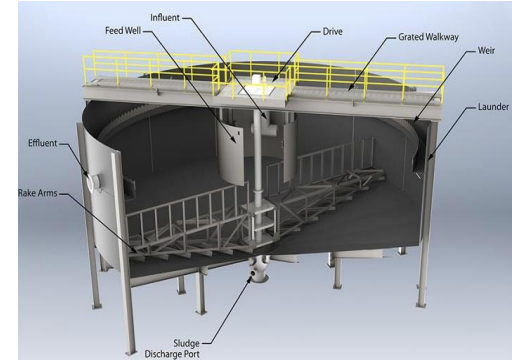
- To **concentrate solids** (2 - 5 times more) and **reduce sludge volume**
- Depending on required capacity
 - hopper bottom
 - rectangular
 - circular in shape
 - Common and similar to clarifiers with picket fences added to scrappers
- Seldomly used in Bangladesh except few units with hopper bottom thickeners or rectangular tanks



Sludge thickening

Gravity thickener

- **Loading rate** (solids load per m² of the tank):
 - Primary 100 kg/m²/day
 - Secondary 25 kg/m²/day
 - Combined ETP: 35 kg/m²/day
- **Retention time**: ≈ 1 day
- Clear **overflow** returned **to equalization** tank
 - Faulty operations resulting in thick sludge overflow (!)
- Effective with combined sludge, not effective with all-biological sludge



Sludge thickening

Dissolved air floatation (DAF) thickener

- Effective for **wasted activated sludge**
- Similar operation like dissolved air floatation in primary treatment:
 - (1) Sludge mixed with compressed air
 - (2) Thickened sludge rising to top
 - (3) Sludge scooped using scum scrapper
- Used for **thickening secondary sludge** (from 1% to 3%)
 - not for heavy primary sludges (!)



Sludge thickening

Dissolved air floatation (DAF) thickener

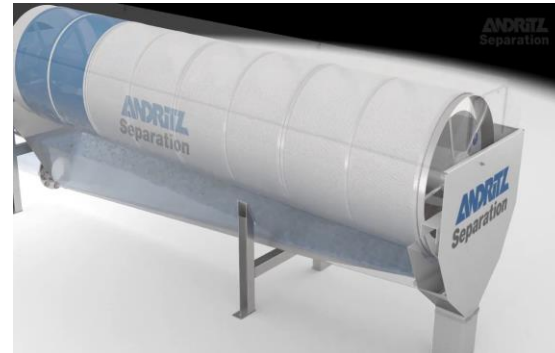
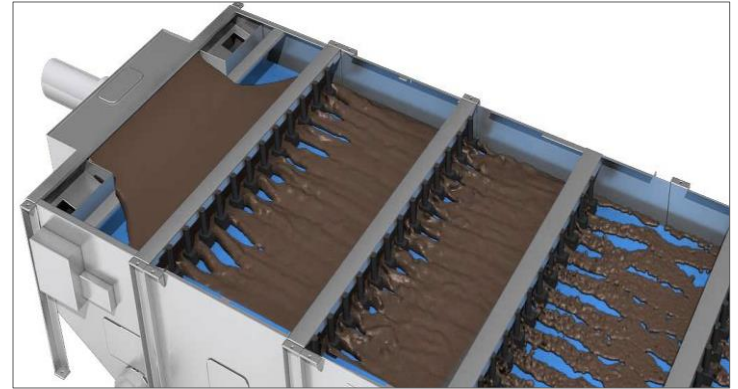
- **Conditioning chemicals** for enhancing thickening
 - Flocculants or polyelectrolytes (quite often)
- **Loading rate** for secondary sludge:
 - 50-120 kg/m²/day of surface without conditioning
 - 200-250 kg/m²/day of surface with conditioning
- **Advantage**
 - Low retention time
 - Sludge staying aerobic
 - Preventing putrefaction avoiding odor



Sludge thickening

Mechanical thickening

- Uncommon Bangladesh
- Common systems
 - **Gravity belt thickener** with sludge passing perforated belt
 - **Rotary drum thickener** with sludge fed into to slowly-rotating vessel with porous walls
 - **Screw thickener** with central screw pressing sludge through rotating multi-disk filters
- Spray system required to clean perforated platforms and prevent pores blockage



Sludge dewatering systems

Sludge dewatering

Chamber filter press

- Most **popular** mechanical sludge dewatering unit for **small and medium ETPs**
- Simple, sturdy and reliable
- Filter plates used as cavities (recessed chambers)



Sludge dewatering

Chamber filter press

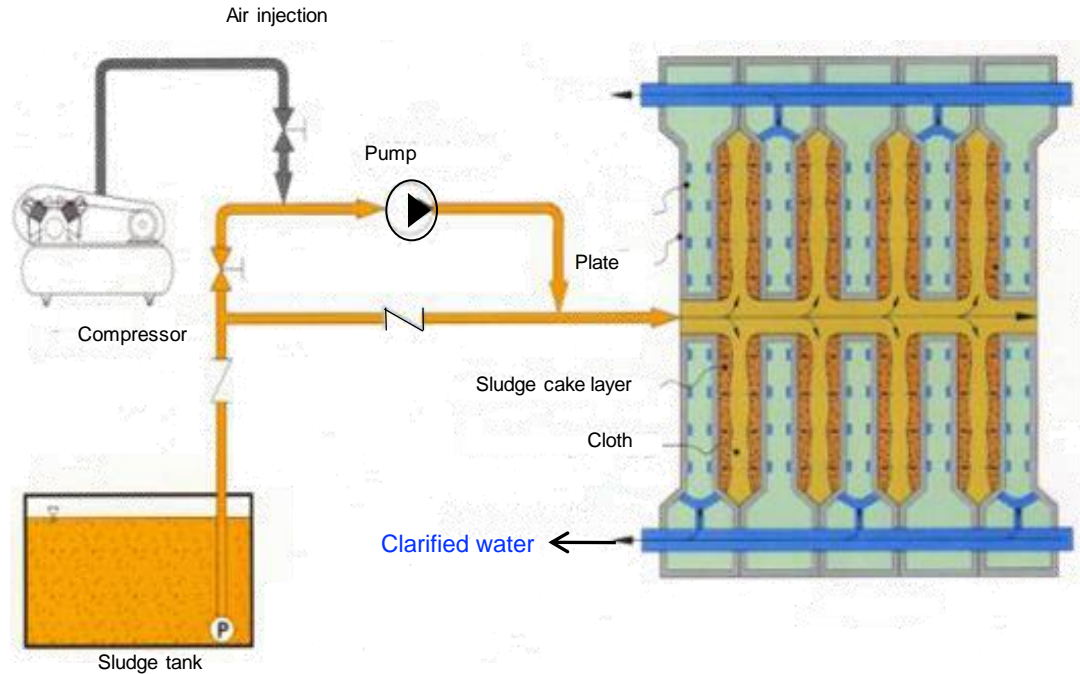
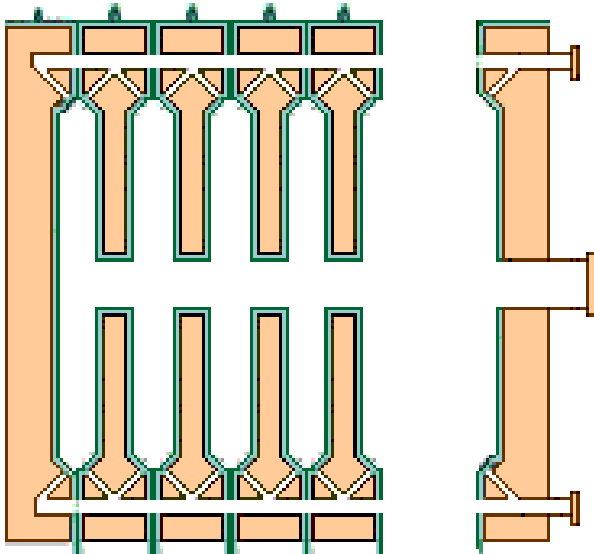
Operation – filtration cycle

- Press with filter plates closed by hydraulic locking cylinder
- Chamber formed between individual filter plates with sludge pumped in under high pressure
- Cake forming by increasing thickness of sludge
- Plates opening and caking fall out
- Filtrate flowing through cloth and discharged through filtrate channel



Sludge dewatering

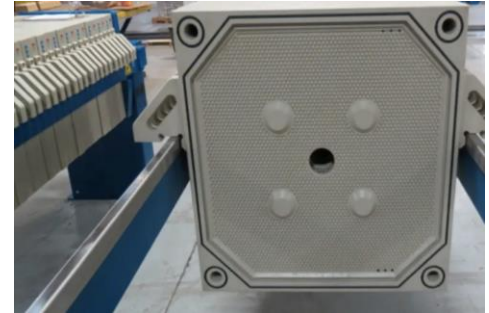
Chamber filter press



Sludge dewatering

Chamber filter press

- **Optional features**
 - Provision for air/steam passing through centre for drier sludge
 - Cake collector in trailer or container
- Advantage
 - **High level of dryness** (moisture reduction by 60-65%)
- Disadvantage
 - **Higher capital cost**
 - Higher **area requirement**
- Conditioning using Ferric chloride/lime



Sludge dewatering

Sludge centrifuge

- Decanter centrifuges most popular in large ETPs
 - Models with vertical and specially horizontal mount
 - Cylindrical bowl rotating at 4000 - 6000 rpm
- Concept:
 - Heavier particles separated faster when rotating at high speeds
 - Slow moving screw conveyor within bowl to transport separated solids to collection bin



Sludge dewatering

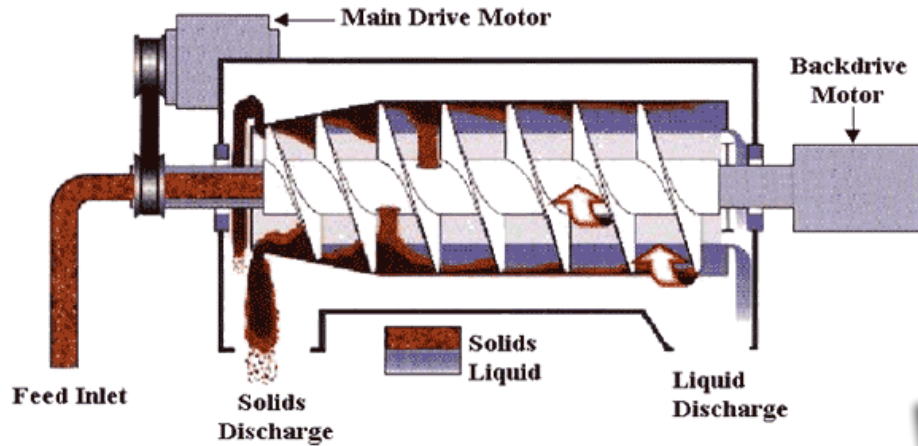
Sludge centrifuge

- Advantages:
 - no odor problem
 - very small area requirement
 - minimum labor requirement
- Disadvantages:
 - high **noise level** during operation
 - high power consumption
 - need for conditioning with polyelectrolyte
 - **high moisture content** in dewatered sludge (75%)



Sludge dewatering

Sludge centrifuge



Sludge dewatering

Belt filter press

- Popular for medium and large ETPs
- Concept:
 - Two moving belts with sludge admitted between these
 - Sludge moving between series of rollers and squeeze
 - Water released and drained by gravity
 - Squeezed and dewatered sludge getting scraped by stationary blade

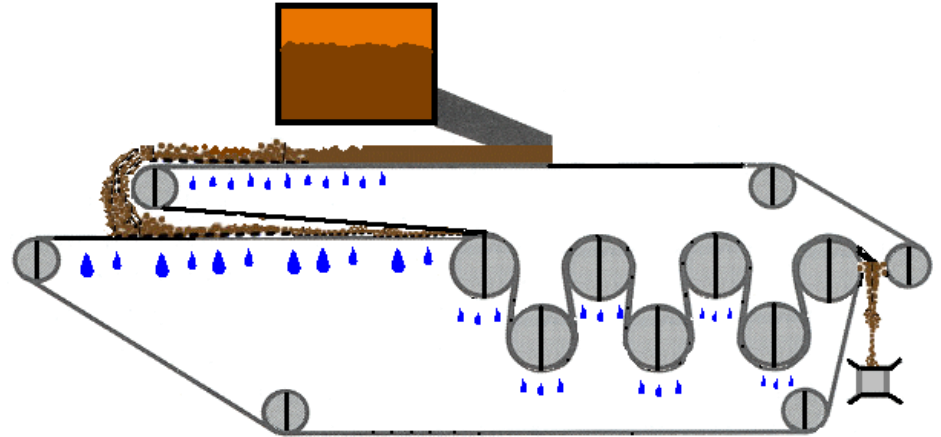


Sludge dewatering

Belt filter press

Important features

- **Jet spray** to wash cloth
- Arrangement to keep **alignment of belts**
- **Differential speed motors** to adjust the speed



Sludge dewatering

Belt filter press

▪ Advantages:

- less pressure pumps required
- very little noise emission
- easy to monitor since open

▪ Disadvantages:

- odor problems
- issues with belt alignment
- lower dryness of sludge (25 - 30%)
- need for polyelectrolyte conditioning (operating cost!)



Sludge dewatering

Sludge drying beds

- Masonry units with no mechanical arrangements
- Suitable for small ETPs if space available
- Set-up:
 - Series of shallow tanks with sloped floor towards center
 - Perforated pipe to collect and drained water
 - Topped with gravel/sand media of different sizes (with finer sand on top)



Sludge dewatering

Sludge drying beds

- Process
 - Liquid sludge pumped in and spread on open bed of sand
 - Allowed to remain until dry
 - Drying through evaporation and gravity drainage
 - 1 week of drying => solids content 35-40%
 - Drained water pumped back to ETP



Sludge dewatering

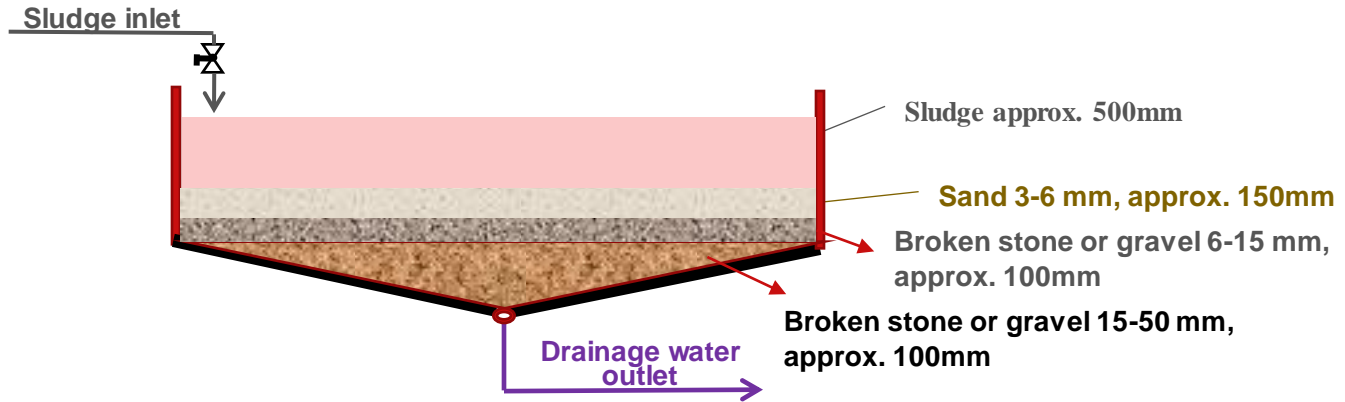
Sludge drying beds

- Advantages
 - **Simple** construction
 - **low maintenance**
 - comparatively **lowest drying costs**
 - **emergency standby** unit during any breakdown of mechanical dewatering equipment
- Disadvantages:
 - high **land requirement**
 - potential for **odor**
 - high **manual labor** requirement



Sludge dewatering

Sludge drying beds



Sludge dewatering

	Decanter	Belt press	Chamber filter press	Sludge drying beds
Way of operation	Continuous	Continuous	Batch	Batch
Sludge dryness	Low	Medium	High	High
Sludge conditioning	required	required	not required	Not required
Washing water	not required	required	not required	Not required
Labor	only supervision	only supervision	required during cake discharge	Required
Sensitive to sludge variability	very sensitive	very sensitive	less sensitive	Less sensitive
Energy required (electricity)	high	medium	low	NA
Maintenance	sophisticated	medium	low	low



**Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH**

Registered offices
Bonn and Eschborn

GIZ Bangladesh
PO Box 6091, Gulshan 1
Dhaka 1212, Bangladesh
T +880 2 5506 8744-52, +880 9666 701 000
F +880 2 5506 8753
E giz-Bangladesh@giz.de
I www.giz.de/bangladesh