



MODERN BRICK INVESTMENT SOLUTIONS

A CATALOG OF OPPORTUNITIES FOR AFRICA'S GREAT LAKES



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
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Swiss Agency for Development
and Cooperation SDC

skat Swiss Resource Centre and
Consultancies for Development

PROECCO PROmoting Employment through
Climate Responsive CONstruction

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Semi-mechanized solutions

A 4-chambered intermittent Hoffman kiln with external chimney located in Rwamagana District.

INTRODUCTION

Modern brickmaking in Africa's Great Lakes



For long time, the clay brick industry was perceived as blue-collar job, practiced by unskilled labourers for low wages and just with only purpose of supporting family farming revenues.

When land scarcity became a major problem in Great Lakes Region of Africa as well as needs to develop urban areas, many people turned to brick and tile production for survival as well as recompensing the revenue losses from agriculture. Hundreds of seasonal brick production units have been seen developing in the region, especially during the dry season. The income generated from those activities are used to compensate loss from agriculture revenues, and then sustain their families.

Though the clay brick industry has potentialities to grow into yearlong and robust industry, more than 90% of brick production units are still operating seasonally due to lack of adequate infrastructure but also lack of the necessary skills (technology, management, production, marketing, etc.) required to produce competitive products and satisfy the market.

Currently, the market for building material is on high demand in the region. The construction sector has much evolved in the last 10 years to be among top 3 sectors that contribute to national GDP.

The housing sector, public infrastructure development as well as commercial buildings are increasing also more than the current supply of building materials due to urbanisation policy and demographic trend.

Total numbers of brick/blocks required for meeting the projected housing demand in the region (with only Rwanda cities estimated at 700 million units per year) are huge. Until now, less than 10 modern factories are producing modern bricks and roof tiles, others are still seasonal and most of them producing traditional bricks which are poor quality for modern construction. This deficit of building material activates much imports of cement (In Rwanda, in 2016: the 1st imports in value: \$17million) and create trade deficit and local unemployment.



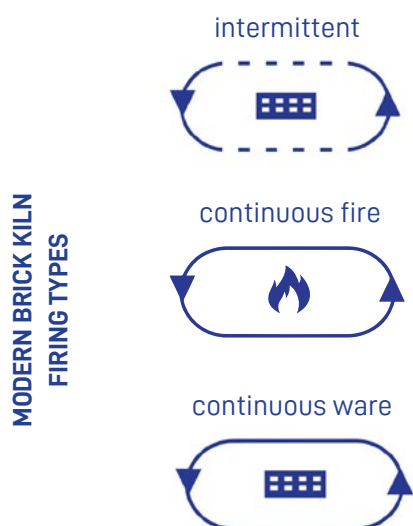
Energy efficiency

A team of technicians power a kiln with sawdust, one of the 4 approved biowaste fuel products



With appropriate support interventions, the brick sector has potentialities to generate high levels of revenue and off-farm employment. The creation of revenue and labour is mostly done through the implementation of brick value chain: supply of raw material and inputs, brick factory, construction of houses, supply of finished products and external service provisions...

This current brick investment catalogue highlights investment opportunities that can be created only in brick production.

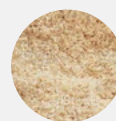


FUEL SOURCE

Available biowaste



Coffee Husk



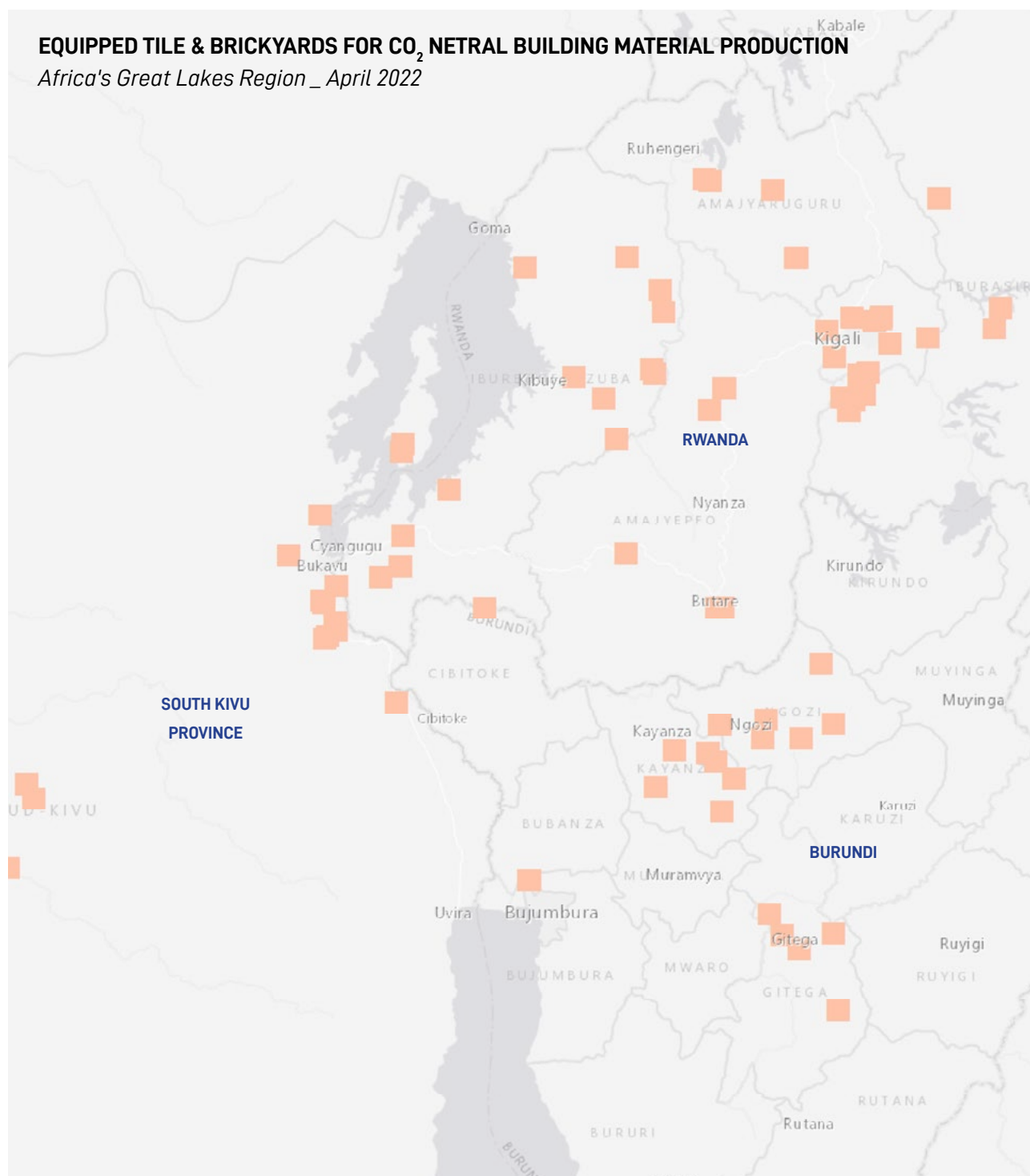
Sawdust



Rice Husk

EQUIPPED TILE & BRICKYARDS FOR CO₂ NETRAL BUILDING MATERIAL PRODUCTION

Africa's Great Lakes Region _ April 2022

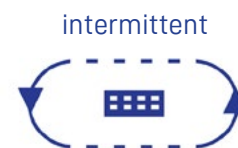


Estimated number of operational enterprises and total production

Country	No. Enterprises	Production (mio bricks/yr)
Rwanda	24	42,600,000
DR Congo (Eastern Province)	5	2,400,000
Burundi	16	8,750,000

starting from
USD **31.000**

01



TRENCH OR UNDERGROUND KILNS

Starter solutions
for manufacturing
modern bricks and
blocks

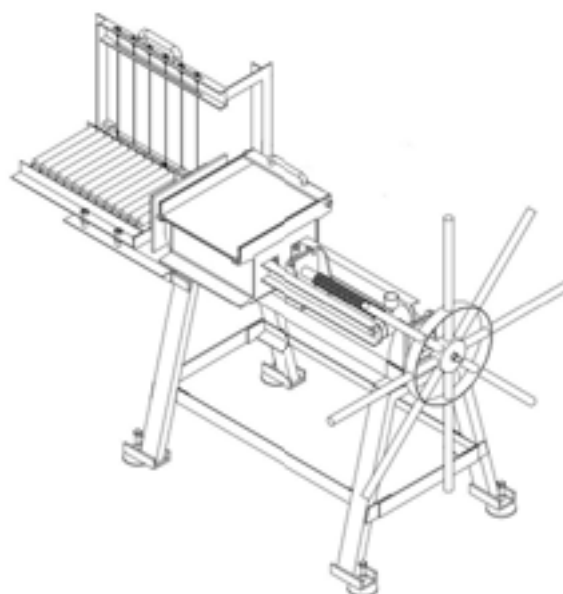
MIO / YR **0.4**

A Starter-Brickyard is a fast and low-cost option for gaining first experiences in Modern Brick production. Although its output is low and the energy consumption is rather high, this technology allows Modern Bricks to be fired at the optimal temperature using 100% legal fuel sources such as sawdust, coffee husk or rice rusk.

Due to frequent supply shortages of modern bricks available on the market, some real estate investors have started to put in place such small production units with the objective to self-supply modern bricks. These units are temporary Chimney and hangar are mobile and can be used to other sites after the completion of construction project. The tunnel dig done during the construction of kiln can also serve as sceptic tank in the future

Investor's Note:

Economically, this is not a profitable business due to 2 factors: low production capacity and fuel consumption. The kiln's lifespan is limited to less than 3 years and firing principle is intermittent. The quality of product is also B- quality.



Manually machines are operated by a team of 3 technicians who can produce up to 1,500 bricks per day, the equivalent of 1 dwelling unit per every 10 days.



**Small-scale
production solutions**

A production manager
supervises the offloading of
fired products from a trench
kiln. The trench kiln can be
converted into a septic



Trench kiln under construction. Recycled fired bricks serve as insulating wall and floor surfaces.



Locally-sourced manual machines are managed by mobile teams that can be deployed on a construction site.



PRODUCTION CAPACITY

Kiln loading capacity: *23.6m³*
 Number of chambers: *1-2*
 Product type: *Hollow/perforated bricks, roof tiles, floor tiles, and solid bricks*
 Production capacity per cycle: *10-11,000 bricks, with maximum of 3 cycles per month*
 Clay required per production cycle: *18.5m³ or 600m³ per year for maximum of 36 production cycles*
 Estimated annual production: *400-500,000 bricks (21cm*10 cm*6 cm brick size)*



ENERGY CONSUMPTION

2.3-2.5 MJ/Kg brick
 Fuel used: *Sawdust, wood, coffee husks*
 Fuel required: *50-70T of sawdust / year*
 Firing principle: *Intermittent*



MACHINES AND EQUIPMENT

Power requirements: *None*
 Machines: *Manual Extruder*
 No. extruder machines: *3*
 Other machines / equipment: *crusher, moulds and other small tools*



INFRASTRUCTURE

Drying type: *Floor*
 Drying Space: *300-400m² Hangar*



WORKFORCE

7-10 labourers



INVESTMENT REQUIRED

Hardware (Kiln, Hangar and Chimney): *\$25,000*
 Machines and equipment: *\$4,000*
 Preliminary fees and working capital: *\$2,000*



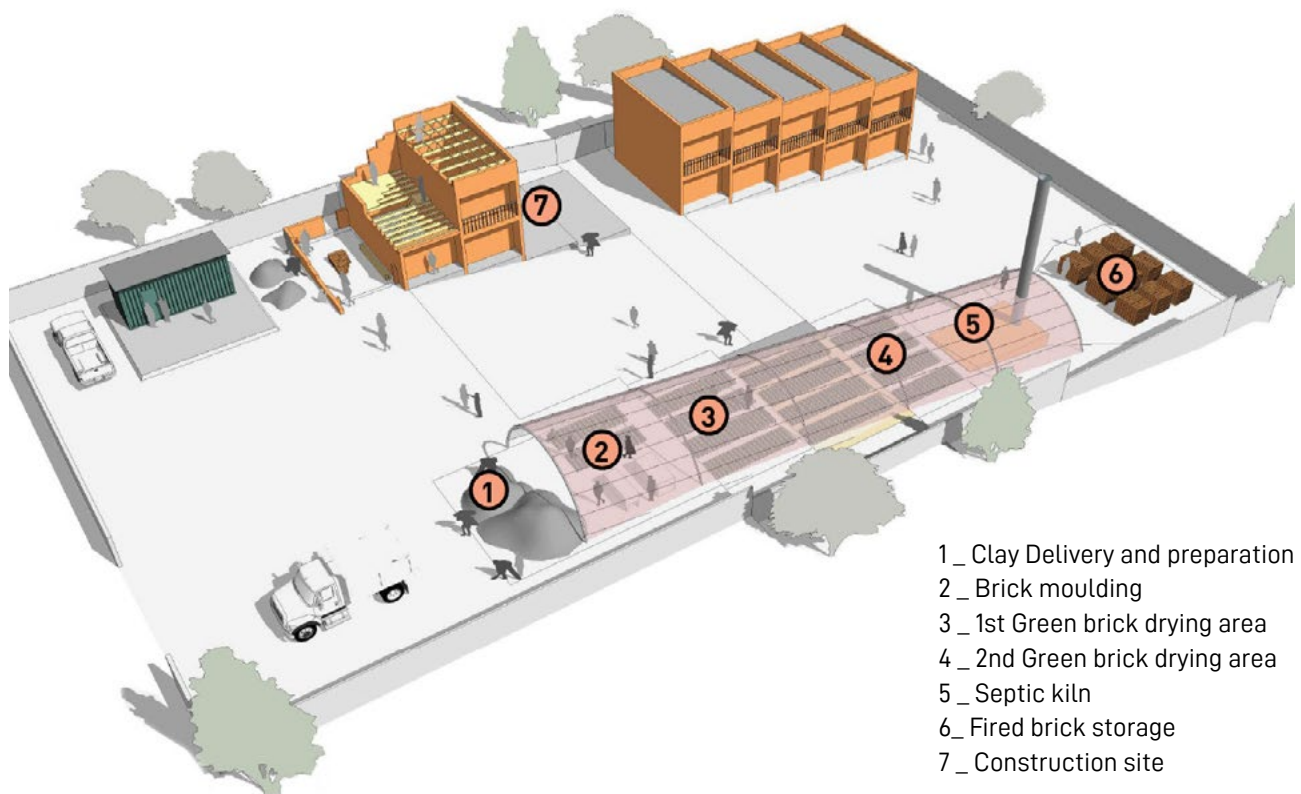
EXPECTED FINANCIAL RETURNS

This model is not meant for commercial purpose. It rather meant to support investors to gain first experience, produce quality bricks for constructing big kiln or just for self-supply of bricks due to current shortage on market.



An in-situ production/construction site is organized to accommodate parallel activities. Here the production manager and her assistant select green bricks for firing, while the site engineer verifies construction details.

TRENCH KILN DEPLOYED ON AN AFFORDABLE HOUSING CONSTRUCTION SITE



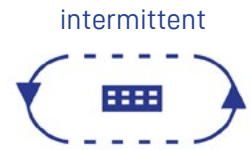
An illustration of the Modern Brick in-situ production site, with mobile infrastructure. The site installation includes hangars for clay preparation and brick moulding by a qualified Mobile Production Team (steps 1 - 4), the trench kiln infrastructure with mobile chimney (step 5), an area for the storage of fired

bricks that will be sorted and counted (6) before being used for the construction of buildings. At the end of this process, the kiln infrastructure will be upgraded into a septic tank for the newly constructed dwelling units.

02

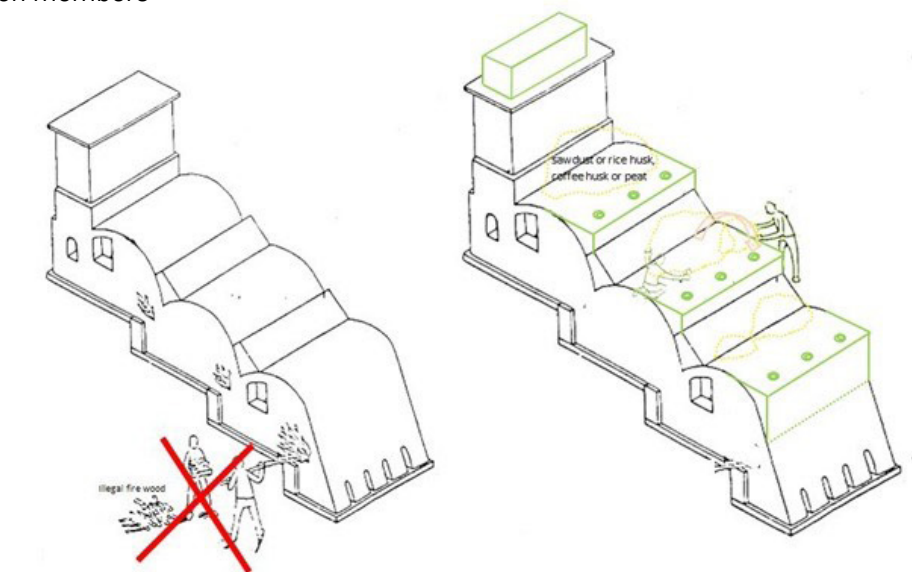
ARTISANAL BRICKYARD UNITS

A local employment
and building material
generator



MIO / YR **0.4**

Artisanal brickyards are made with climbing kilns or structured kilns supported by elementary hangars (often constructed with wood, mixed with bricks as structure) and manual machines. Production technology is 100% hand made. Most of these kilns have been constructed with government support to cooperatives, associations with the purpose of creating local employment as well as substitution to agricultural farming. The investment returns are only in form of permanent jobs to cooperation/association members



Kilns upgraded by the PROECCO project replace firewood with biowaste, preventing the continued destruction of native forests for fuel.



02.1 Climbing Kiln Brickyard STANDARD

MIO / YR **0.3** 

starting from
USD **18.000**



PRODUCTION CAPACITY



Kiln loading capacity: 24-32m³
No. chambers: 3-4
Type of products: *Hollow/perforated bricks, roof tiles, floor tiles, and solid bricks*
Production capacity per cycle: 10-11.000 bricks, with maximum of 3 cycles per month
Clay required per production cycle: 18.5m³ or 600m³ per year for maximum of 36 production cycles
Estimated annual production: 300-400,000 bricks (RLB size)

ENERGY CONSUMPTION



2.5-2.8MJ/Kg brick
Fuel used: *Sawdust, wood, coffee husks*
Fuel required: 50-70T of sawdust / year
Firing principle: *Intermittent*

MACHINES AND EQUIPMENT



Power requirements: *Manual*
Machines: *Manual Extruder or motorised*
No. extruder machines: 3 or 1 motorised machine
Other machines / equipment: *crusher (optional), moulds and other small tools*

INFRASTRUCTURE



Drying Type: *Floor*
Drying Space: 300-400m² Hangar

WORKFORCE



7-10 labourers

INVESTMENT REQUIRED



Hardware: USD 10-15
Machines and equipment: USD 4.000
Preliminary fees and working capital: USD 2.000

EXPECTED FINANCIAL RETURNS



Annual Turnover (bricks): USD 30-35,000
Payback period: 7 years


02.2 Climbing Kiln Brickyard MEDIUM

MIO / YR **1.5** 


starting from
USD **68.500**




PRODUCTION CAPACITY

 Kiln loading capacity: 120m³
No. chambers: 5-6
Type of products: *Hollow/perforated bricks, roof tiles, floor tiles, and solid bricks*
Production capacity per cycle: 50-60.000 bricks, with maximum of 3 cycles per month
Clay required per production cycle: 96m³ or 2.300m³ per year for maximum of 24 production cycles
Estimated annual production: 1.5-2.000.000 bricks (RLB size)

ENERGY CONSUMPTION

 2.0-2.3 MJ/Kg brick
Fuel used: *Sawdust, wood, coffee husks*
Fuel required: 200T of sawdust / year
Firing principle: *Intermittent*


MACHINES AND EQUIPMENT

 Power requirements: *Manual*
Machines: *Manual Extruder*
No. extruder machines: 10
Other machines / equipment: *crusher, moulds and other small tools*


INFRASTRUCTURE

 Drying Type: *Floor*
Drying Space: 1.200-1.500m² Hangar

WORKFORCE

 30-50, including casual workers

INVESTMENT REQUIRED

 Hardware: USD 35-40.000
Machines and equipment: USD 18.000
Preliminary fees and working capital: USD 15.500

EXPECTED FINANCIAL RETURNS

 Annual Turnover (bricks): USD 100-120.000
Payback period: 4 years
Total unit cost (prix de revient) : USD 66/1.000 bricks

02.3 Artisanal Tunnel Kiln (Four Tunnel)

MIO / YR **0.4** 

starting from
USD **23.000**



PRODUCTION CAPACITY



Kiln loading capacity: *23.6m³*
 No. chambers: *1-2*
 Type of products: *Hollow/perforated bricks, roof tiles, floor tiles, and solid bricks*
 Production capacity per cycle: *10-11.000 bricks, with max. of 3 cycles per month*
 Clay required per production cycle: *18.5m³ or 600m³ per year for maximum of 36 production cycles*
 Estimated annual production: *400-500,000 bricks (21cm*10 cm*6 cm brick size)*

ENERGY CONSUMPTION



2.5 -2.8MJ/Kg brick
 Fuel used: *Sawdust, wood, coffee husks*
 Fuel required: *60T of sawdust / year*
 Firing principle: *Intermittent*

MACHINES AND EQUIPMENT



Power requirements: *Manual*
 Machines: *Manual Extruder*
 No. extruder machines: *3*
 Other machines / equipment: *crusher (optional), moulds and other small tools*

INFRASTRUCTURE



Drying Type: *Floor*
 Drying Space: *300-400m² Hangar*

WORKFORCE



15-20, including casual workers

INVESTMENT REQUIRED



Hardware: *USD 15-20.000*
 Machines and equipment: *USD 3-5.000*
 Preliminary fees and working capital: *USD 5-7.000*

EXPECTED FINANCIAL RETURNS

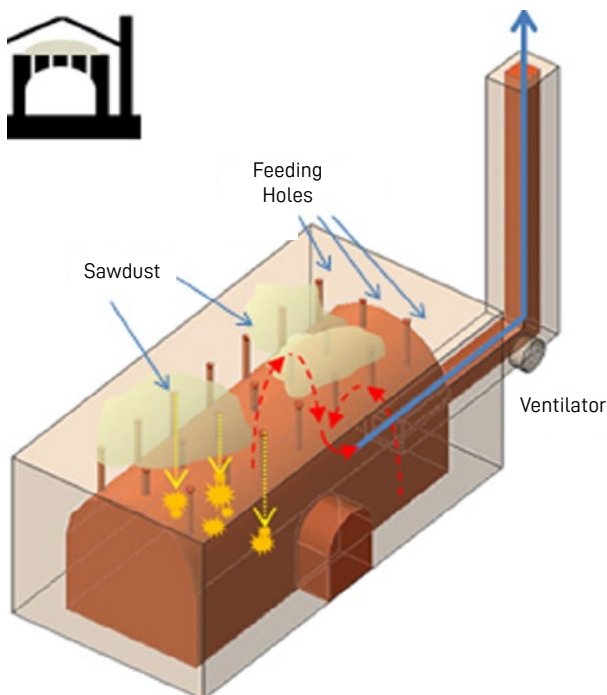


Annual Turnover (bricks): *USD 16-20.000*
 Payback period:
 Total unit cost (prix de revient) :

02.4 Ugandan Kiln

MIO / YR **0.8** 

starting from
USD **51.500**



PRODUCTION CAPACITY

Kiln loading capacity: 48m³

No. chambers: 2

Type of products: *Hollow/perforated bricks, roof tiles, floor tiles, and solid bricks*

Production capacity per cycle: 20-25.000 bricks, with maximum of 3 cycles per month
Clay required per production cycle: 40m³ or 1.400m³ per year for maximum of 24 production cycles

Estimated annual production: 750-800,000 bricks (RLB size)

ENERGY CONSUMPTION

2.0-2.3MJ/Kg brick

Fuel required: 120-130T of sawdust / year

Firing principle: *Intermittent*

MACHINES AND EQUIPMENT

Power requirements: *Manual*

Machines: *Manual Extruder*

No. extruder machines: 6

Other machines / equipment: *crusher, moulds and other small tools*

INFRASTRUCTURE

Drying Type: *Floor*

Drying Space: 1.000-1.200m² Hangar

WORKFORCE

20-28, including casual workers

INVESTMENT REQUIRED

Hardware: USD 30-35.000

Machines and equipment: USD 13.500

Preliminary fees and working capital: USD 8-9.000

EXPECTED FINANCIAL RETURNS

Annual Turnover (bricks): USD 50-60.000

Payback period: 7-9 years

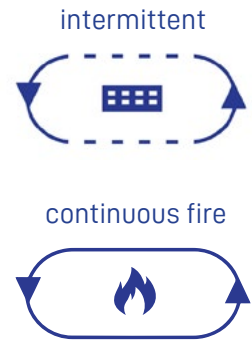
Total unit cost (prix de revient) : USD 70/1.000 bricks

03

SEMI-MECHANIZED BRICKYARD UNITS

Energy-efficient
brick production
solutions

USD 0 150K 565K 1 mio



MIO / YR **0.4** 

Due to energy consumption and high demand for modern bricks, medium to large enterprises in great lakes region have turned to more efficient and continuous brick kilns solution. The needs to produce continuously modern bricks have pushed them to import new firing technology, i.e, zigzag kiln and Hoffman.

Today in great lakes region, there are different types of brick kilns that are being constructed and used: 4-chamber Hoffman kiln, standard 8-chamber zigzag kiln, medium sized 8-chamber zigzag kiln, Large 8-chamber zigzag kiln, 12-chamber zigzag kiln (under investigation) ... Except 4- chamber Hoffman kiln, other kilns are continuous (firing never stops)



Mechanized extruders facilitate the production of a variety of large brick and block products.



03.1 Hoffman Kiln

Four (4) chambers

MIO / YR **2.0** 

starting from
USD **150.000**



PRODUCTION CAPACITY

Kiln loading capacity: 120m³

No. chambers: 2

Type of products: *Hollow/perforated bricks, Blocks, roof tiles, floor tiles, and solid bricks*

Production capacity per cycle: 55-60.000 bricks, with maximum of 3 cycles per month

Clay required per production cycle: 80m³ or 3.000m³ per year for maximum of 36 production cycles

Estimated annual production: 2-2.200,000 bricks (RLB size)

ENERGY CONSUMPTION

1.5-2.0 MJ/Kg brick

Fuel used: *Sawdust, wood, coffee husks*

Fuel required: 250-270T of sawdust / year

Firing principle: *Intermittent / continuous*

MACHINES AND EQUIPMENT

Power requirements: *Manual or motorised*

No. manual machines: 10

No. motorised extruder machines: 1 line

Other machines / equipment: *Tipper truck [optional], Dumper, Ventilator,*

Wheel barrows, Generator (back-up),

Thermocouple & other measurement tools, moulds and other small tools

INFRASTRUCTURE

Drying Type: *Floor*

Drying Space: 1.500-1.800m² Hangar

WORKFORCE

25-30, including casual workers

INVESTMENT REQUIRED

Hardware: USD 80-100.000

Machines and equipment: USD 50-60.000

Preliminary fees and working capital: USD 20-25.000

EXPECTED FINANCIAL RETURNS

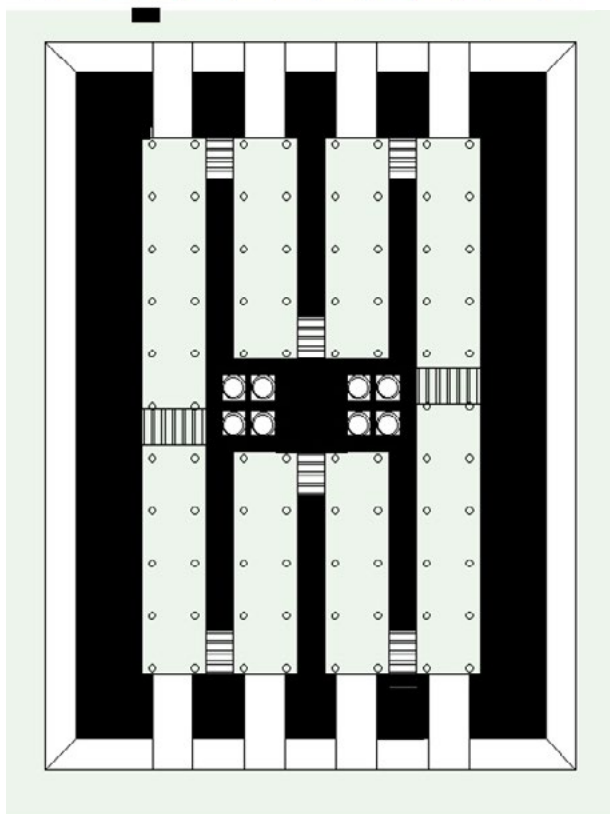
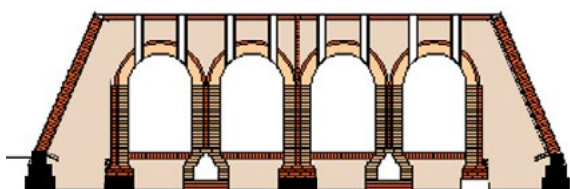
Annual Turnover (bricks): USD 140-180.000

Payback period: 4.8 years

Total unit cost : USD 73/1.000 bricks

03.2 ZigZag Kiln Eight (8) chambers SMALL

MIO / YR **3.0**  starting from
USD **175.000**



PRODUCTION CAPACITY

Kiln loading capacity: 140m³

No. chambers: 8

Type of products: *Hollow/perforated bricks, Blocks, Max-pans, roof tiles, floor tiles, and solid bricks*

Production capacity per month: 250-300.000 bricks

Clay required per year: 4.500m³

Estimated annual production: 3-3.500.000 bricks (RLB size)

ENERGY CONSUMPTION

1.5-2.0 MJ/Kg brick

Fuel used: *Sawdust, coffee husks*

Fuel required: 350-380T of sawdust / year

Firing principle: *continuous*

MACHINES AND EQUIPMENT

Power requirements: *Motorised*

No. motorised extruder machines: 1 line

Other machines / equipment: *Excavator, Tipper truck, Dumper, Wheel barrows, Generator (back-up), Thermocouple & other measurement tools, moulds and other small tools*

INFRASTRUCTURE

Drying Type: *Floor*

Drying Space: 2.000-2.500m² Hangar

WORKFORCE

40-50, including casual workers

INVESTMENT REQUIRED

Hardware: USD 100-120.000

Machines and equipment: USD 50-60.000

Preliminary fees and working capital: USD 25-30.000

EXPECTED FINANCIAL RETURNS

Annual Turnover (bricks): USD 250-260.000

Payback period: 3.8 years

Total unit cost (prix de revient) : USD 69/1.000 bricks

03.3 ZigZag Kiln

Eight (8) chambers MEDIUM

MIO / YR **4.8** starting from
USD **310.000**



PRODUCTION CAPACITY

Total Kiln loading capacity: 238m³

No. chambers: 8

Type of products: *Hollow/perforated bricks, Blocks, Max-pans, roof tiles, floor tiles, and solid bricks*

Production capacity per month: 425-450.000 bricks

Clay required per year: 7-7.500m³

Estimated annual production: 4.8-5.000.000 bricks (RLB size)



ENERGY CONSUMPTION

1.5-2.0 MJ/Kg brick

Fuel used: *Sawdust, coffee husks*

Fuel required: 600-650T of sawdust / year

Firing principle: *continuous*



MACHINES AND EQUIPMENT

Power requirements: *Motorised*

No. motorised extruder machines: 1 production line

Other machines / equipment: *Excavator, Tipper truck, Dumper, Wheel barrows, Generator (back-up), Thermocouple & other measurement tools, moulds and other small tools*



INFRASTRUCTURE

Drying Type: *Floor*

Drying Space: 3.000-4.500m² Hangar



WORKFORCE

60-70, including casual workers



INVESTMENT REQUIRED

Hardware: USD 170-200.000

Machines and equipment: USD 100-120.000

Preliminary fees and working capital: USD 40-45.000



EXPECTED FINANCIAL RETURNS

Annual Turnover (bricks): USD 450-500.000

Payback period: 3.3 years

Total unit cost (prix de revient) : USD 63/1.000 bricks

03.4 ZigZag Kiln

Eight (8) chambers LARGE

MIO / YR **6.0** starting from
USD **495.000**



PRODUCTION CAPACITY

Kiln loading capacity: 282m³

No. chambers: 8

Type of products: *Hollow/perforated bricks, Blocks, Max-pans, roof tiles, floor tiles, and solid bricks*

Production capacity per month: 500-550.000 bricks

Clay required per year: 9.000m³

Estimated annual production: 6-6.500,000 bricks (RLB size)

ENERGY CONSUMPTION

1.5-2.0 MJ/Kg brick

Fuel used: *Sawdust, coffee husks*

Fuel required: 700-800 T of sawdust / year

Firing principle: *continuous*

MACHINES AND EQUIPMENT

Power requirements: *Motorised*

No. motorised extruder machines: 1 production line

Other machines / equipment: *Excavator, Tipper truck, Dumper, Wheel barrows, Generator (back-up), Thermocouple & other measurement tools, moulds and other small tools*

INFRASTRUCTURE

Drying Type: *Floor*

Drying Space: 5.000-6.000 m² Hangar

WORKFORCE

70-80, including casual workers

INVESTMENT REQUIRED

Hardware: USD 250-280.000

Machines and equipment: USD 200-250.000

Preliminary fees and working capital: USD 45-50.000

EXPECTED FINANCIAL RETURNS

Annual Turnover (bricks): USD 560-600.000

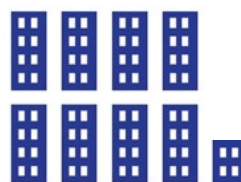
Payback period: 3.4 years

Total unit cost (prix de revient) : USD 60/1.000 bricks

03.5 ZigZag Kiln

Eight (8) chambers XL

MIO / YR **8.5**



starting from
USD **565.000**



PRODUCTION CAPACITY

Kiln loading capacity: 295 m³

No. chambers: 8

Type of products: *Hollow/perforated bricks, Blocks, Max-pans, roof tiles, floor tiles, and solid bricks*

Monthly capacity: 700-750.000 bricks

Clay required per year: 13.500 m³

Estimated annual production: 8.5-9.000,000 bricks (RLB size)

ENERGY CONSUMPTION

1.5-2.0 MJ/Kg brick

Fuel used: *Sawdust, coffee husks*

Fuel required: 1.000-1.200 T of sawdust / year

Firing principle: *Continuous*

MACHINES AND EQUIPMENT

Power requirements: *Motorised*

No. motorised extruder machines: 1
production line

Other machines / equipment: *Excavator, Tipper truck, Dumper, Wheel barrows, Generator (back-up), Thermocouple & other measurement tools, moulds and other small tools*

INFRASTRUCTURE

Drying type: *Floor*

Drying Space: 7-8.000m² Hangar

WORKFORCE

100-120, including casual workers

INVESTMENT REQUIRED

Hardware: USD 200.000 - 240.000

Machines and equipment: USD 300-400.000

Preliminary fees and working capital: USD 65-70.000

EXPECTED FINANCIAL RETURNS

Annual Turnover (bricks): USD 800-840.000

Payback period: 3 years

Total unit cost (prix de revient) : USD 58/1.000 bricks



starting from
USD **45.000**

04



VERTICAL SHAFT BRICK KILN (VSBK)

Semi-industrial
pioneer in modern
brick production

MIO / YR **0.4** 

The Vertical shaft brick kiln (VSBK) is a continuous, updraft, moving ware kiln in which the fire remains stationary while there is counter current heat exchange between air (moving upward) and bricks (moving downward).

The VSBK technology has evolved from the traditional up-draught kilns in rural China during late 1950s. However, the widespread dissemination of the technology took place after the economic reforms. At its peak during the mid-1990s, thousands of VSBKs were reported to be operating in China.

Since 1990, under different technology transfer projects the technology has been transferred to several developing countries including India, Nepal and Vietnam.

In 2014, Skat Consulting Ltd through the Swiss Agency for Development and Cooperation's industry facilitation project (PROECCO) introduced this technology to the Great Lakes Region of Africa with the objective to test the technical and economic feasibility of this technology. The prototype was constructed in Ngororero District, Western Province of Rwanda

and is being tested with different fuels available in the country.

Investor's Note:

This technology uses coal as the main source of fuel. In our region there is no coal and its importation is costly. Different alternative solutions are still being tested: peat, charcoal powder and sawdust.



VSBK

Rwanda's first Vertical Shaft Brick Kiln serves as a testing and training site for apprentice technicians.



A small production line consists of a crusher and motorized extruder with vacuum pump.



Large hangars are used to store products before firing. The hangars are designed to allow sufficient airflow to uniformly dry the products.



PRODUCTION CAPACITY

Kiln loading capacity: 15 m³
 Type of products: *Hollow/perforated bricks, Blocks, Max-pans, roof tiles, floor tiles, and solid bricks*
 Production capacity per month: 40-42.000 bricks
 Clay required per year: 770 m³
 Estimated annual production: 400-500,000 bricks (RLB size)



ENERGY CONSUMPTION

0.8-1.0 MJ/Kg fired brick
 Fuel required: 100-120 T of peat and charcoal (80%-20%) / year
 Firing principle: *Intermittent*



MACHINES AND EQUIPMENT

Power requirements: *Manual or Motorised*
 No. motorised extruder machines: 1 extruder machine + crusher
 Other machines / equipment: *Wheel barrows, Generator (back-up), Thermocouple & other measurement tools, moulds and other small tools*



INFRASTRUCTURE

Drying Type: *Floor*
 Drying Space: 1.500 m² Hangar



WORKFORCE

15-20 labourers



INVESTMENT REQUIRED

Hardware: USD 20-25.000
 Machines and equipment: USD 15-20.000
 Preliminary fees and working capital: USD 10-15.000

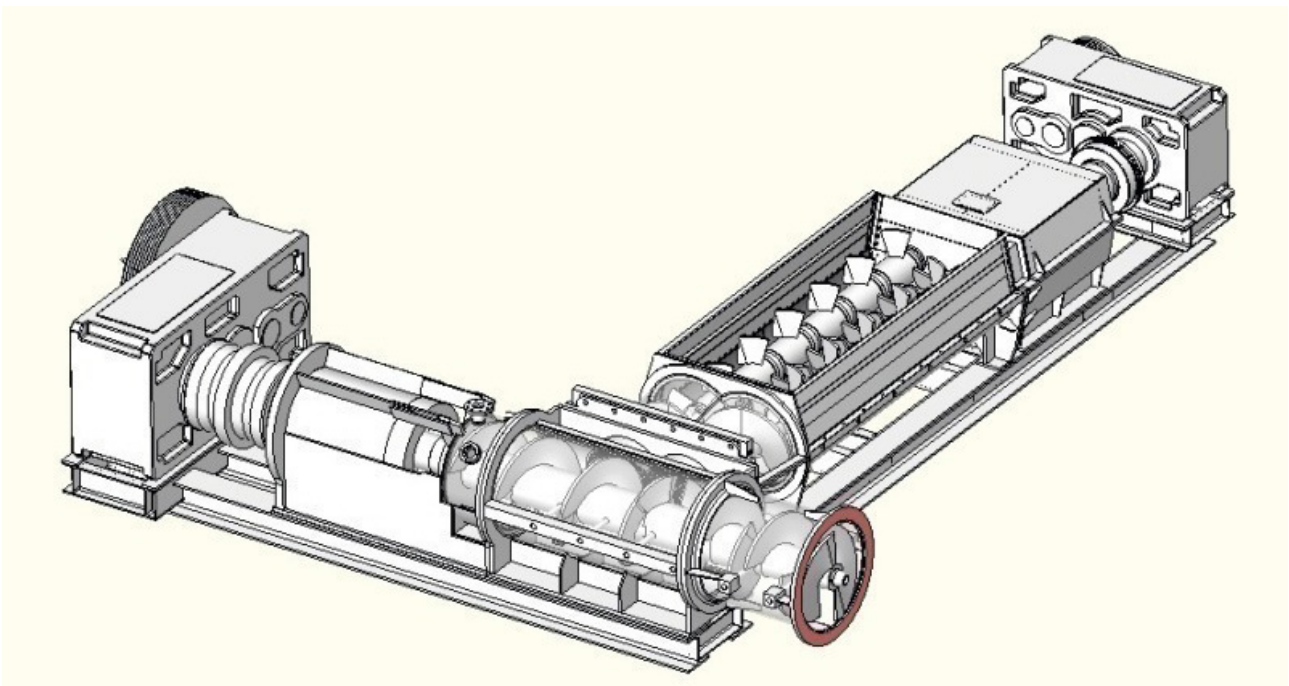


EXPECTED FINANCIAL RETURNS

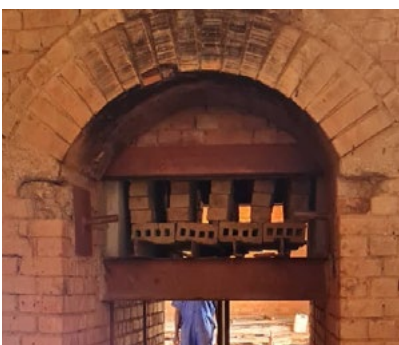
Annual Turnover (bricks): USD 25-35.000
 Payback period: 6-8 years
 Total unit cost (prix de revient) : USD 70/1.000 bricks



The VSBK campus in Rwanda's Western Province (Ngororero District) is serving as a training facility and testing laboratory for alternative fuels. In 2023, the kiln will be adapted to the production and firing of another environment-friendly building material: low-calcinated cement (LC3).



Top: Mechanized extrusion machine with double shaft mixer and extruder. Bottom: Hydraulic firing plate mechanism.

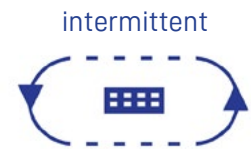


starting from
USD **1.000.000**

05

MOBILE KILN PRODUCTION UNIT

How to use this
great satisfying book
and actually learn
something



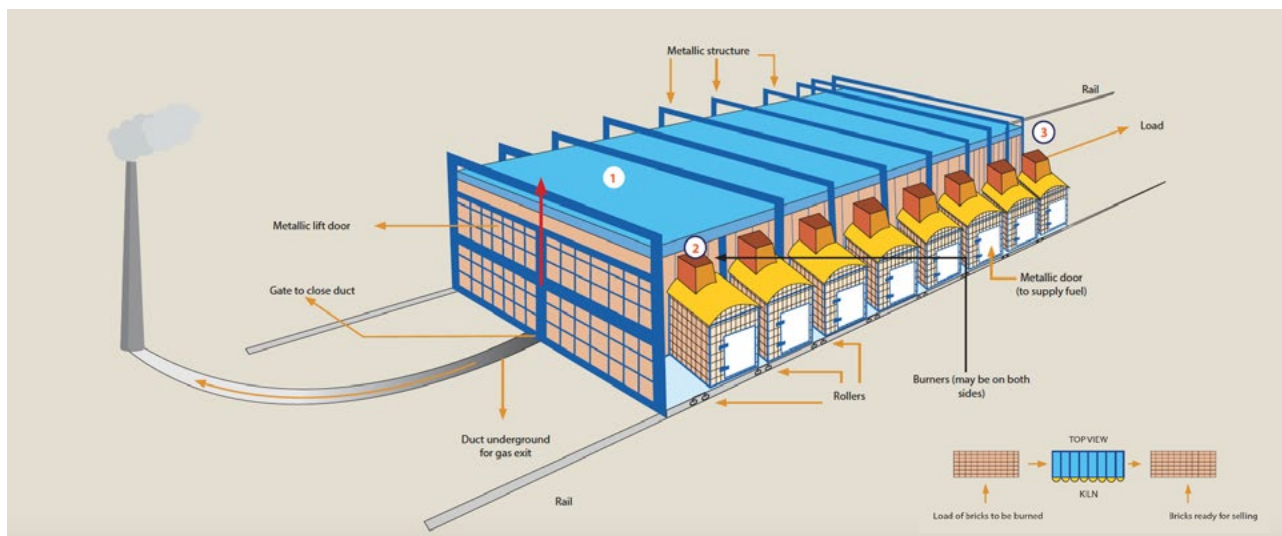
Mobile Kiln is a model in which the entire structure of the kiln can be moved using a rail system and stacked over the green bricks previously loaded for burning. The burners are coupled along the side of the kiln. The structure of this kiln is very lightweight, because it only uses ceramic fiber and steel layers.

- The Mobile Kiln has a rectangular shape and its dimensions can be quite variable, with width ranging from 3.4 to 9.4 m and length from 15m to 30m.
- In the Mobile Kiln the brick loading is stacked and the structure of the kiln moves along the rails on the floor with the support of pushers/handles.
- The firing cycle tends to be shorter compared with the traditional kilns, due to its lighter structure that absorbs less heat, and saves time in charging and discharging of materials.
- The structure is made basically of metal and insulated with ceramic fiber.

Investor's Note:

This is a long-term investment, more than 30 years. For the first years, some investors may face difficulties in cash flow. The cost of capital may also be a limitation for some investors who don't have money to invest in. In this case, equity-loan options may be evaluated beforehand.

The other limitation is that a mobile kiln is an intermittent technology that may consume more energy than existing ones.



The Mobile Kiln is an industrialized mechanized kiln that produces high-quality heavy ceramic products.

The Mobile Kiln technology was developed and deployed in South America, mostly in Brazil where they have +100 units.



PRODUCTION CAPACITY

Type of products: *Hollow/perforated bricks, Blocks, Max-pans, roof tiles, floor tiles, and solid bricks*
 Production capacity per month: *600-1.000.000 bricks*
 Clay required per year: *15-16.000 m3*
 Estimated annual production: *6-12.000.000 bricks (RLB size)*



ENERGY CONSUMPTION

1.5-1.8 MJ/Kg fired brick
 Fuel required: *Biomass (eg. biomass briquettes, sawdust).*
 Firing principle: *Intermittent*



MACHINES AND EQUIPMENT

Power requirements: *Motorised*
 No. motorised extruder machines: *1 line*
 Other machines / equipment: *Excavator, Tipper truck, Dumper, Wheel barrows, Generator (back-up), Thermocouple & other measurement tools, moulds and other small tools*



INFRASTRUCTURE

Drying Type: *Floor*
 Drying Space: *±10.000 m2 Hangar*
 Office: *±50 m2*



WORKFORCE

No. operators required: 6, plus some casual workers estimated at 10-15 people



INVESTMENT REQUIRED

Hardware: *USD 1 - 1.500.000*
 For annual production capacity of 6 - 12 million bricks per annum: *USD 700.000-1.500.000*



EXPECTED FINANCIAL RETURNS

Annual Turnover (bricks): *USD 400-800.000*
 Payback period: *4-5 years*
 Total unit cost (prix de revient) : *USD 70/1.000 bricks*

starting from
USD **3.000.000**

06

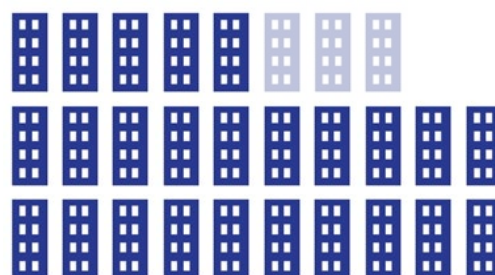
continuous ware



INDUSTRIAL UNIT RULIBA TYPE

High-capacity,
high-quality
production solutions

MIO / YR **25.0**



Tunnel kiln is a continuous moving ware kiln in which the clay products to be fired are passed on cars through a long horizontal tunnel. The firing of products occurs at the central part of the tunnel. The tunnel kiln is considered to be the most advanced brick making technology. The main advantages of tunnel kiln technology lie its ability to fire a wide variety of clay products, better control over the firing process and high quality of the the products.

The tunnel kiln technology was developed around mid-19th century in Germany. However, the application of the technology for brick firing took place in the 20th century. After the Second World War, the technology was widely adopted and led to the transformation of the European brick industry from several thousand small and scattered brick making units into a few hundred large scale and highly mechanised tunnel kiln units.

Asia, China and Vietnam began adopting the technology in the 1970s and now have several hundred tunnel kilns in operation. In India, there are very few (~5) tunnel brick kiln units.

Tunnel kilns are low maintenance and require less manual labour to operate, freeing up employees. They are generally maintained on an annual or bi-annual basis during shutdown periods.

With a tunnel kiln, the price per piece investment cost in terms of energy and equipment are also lower for high volume production.

To date, the only unit of this type , this unit is only constructed in Rwanda, Kigali.

Investor's note:

The industrial sized tunnel kiln is a long-term investment, likely more than 30 years. Cash flow and/or the cost of capital may pose a limitation to some, who may in turn choose equity-loan options.

The recommended use of a tunnel kiln is for a constant, high-volume production of heavy ceramic products. The variable cycle time of tunnel kilns makes them ideal for integration into a continuous and/or automated production line.



Ruliba Clays (Rwanda)

Built in the early 1980s, the Ruliba factory remains the gold standard of industrial brickyards in the Great lakes Region.



High-capacity mechanized extruder permits simultaneous extrusion of multiple products.



Powerful vacuum pump permits the extrusion of large volumes with many perforations, saving on material and firing costs.



PRODUCTION CAPACITY

Type of products: *Hollow/perforated bricks, Blocks, Max-pans, roof tiles, floor tiles, and solid bricks*

Estimated annual production: *25-28.000.000 bricks (Brick10' size)*



ENERGY CONSUMPTION

0.8-1.0 MJ/Kg fired brick

Fuel required: *2.500-2.800 T of sawdust or coffee husks / year*

Firing principle: *Continuous*



MACHINES AND EQUIPMENT

Power requirements: *Motorised*

Other machines / equipment: *Excavator, Tipper truck, Dumper, Wheel barrows, Generator (back-up), Thermocouple & other measurement tools, moulds and other small tools*



INFRASTRUCTURE

Drying Type: *Floor*

Drying Space: *±15.000 m2 Hangar*



WORKFORCE

150-200, including casual workers



INVESTMENT REQUIRED

USD 3-4.000.000



EXPECTED FINANCIAL RETURNS

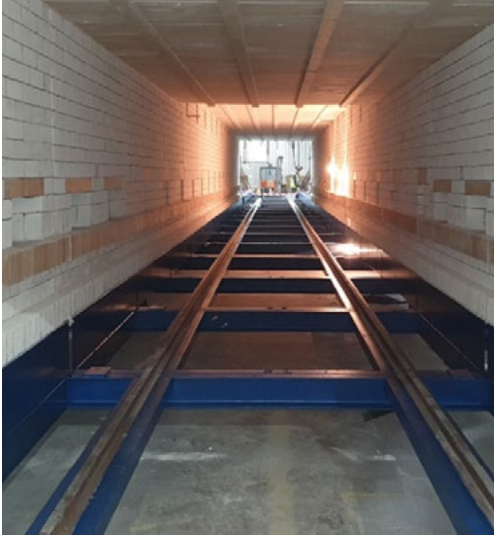
Annual Turnover (bricks): *USD 1.5-2.000.000*

Payback period: *6-8 years*

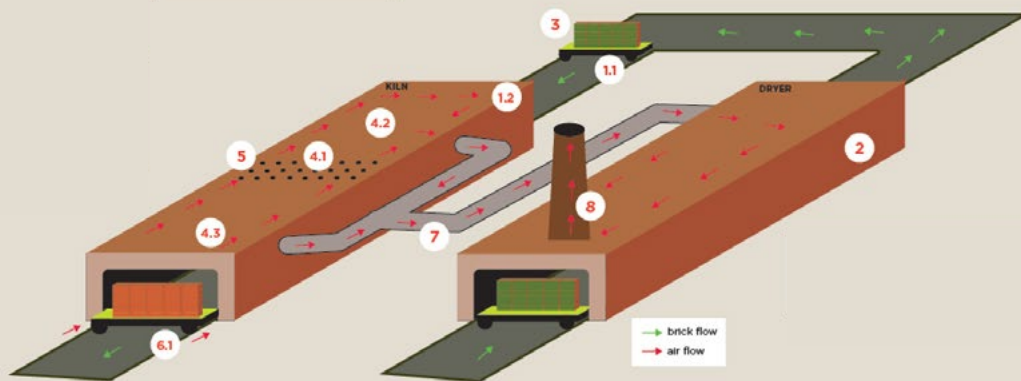
Total unit cost (prix de revient) : *USD 70/1.000 bricks*



Production lines with high-powered vacuum pumps facilitate the production of such high-return products like the Maxpan slab.



Top: Graphic illustration of tunnel kiln automated production cycle. Bricks are loaded on cars that are fed through a tunnel. Recycled heat from the kiln is pumped into a dryer to speed up the drying process. Bottom left: Inside a tunnel kiln with rails. Bottom right: Photo of tunnel kiln on the left and dryer with metal doors on the right.



1. In a tunnel kiln, a continuous moving ware kiln, the clay products/bricks to be fired are passed on cars (1.1) through a long horizontal tunnel (1.2). The firing of bricks occurs at the central part of the tunnel. The length of tunnel can vary from 60 m to 150 m.
2. Generally green bricks are produced by mixing powdered fuel with clay. Green bricks are then moved in the tunnel or chamber dryers on cars for drying. Heat from the hot flue gases coming out of the kiln is utilized for the drying of bricks.
3. The cars loaded with dried green bricks are pushed in the kiln. The cars are moved inside the kiln intermittently at fixed time intervals. The duration of the firing cycle can range from 30 to 72 hours.
4. Three distinct zones appear in an operating tunnel kiln: 4.1 Brick firing zone where the fuel is fed and combustion is happening, 4.2 Brick preheating zone (before the firing zone) where the green bricks are being pre-heated by the hot flue gases coming from the firing zone and 4.3 Brick cooling zone (ahead of the firing zone) where fired bricks are cooled by the cold air flowing into the kiln.
5. Fuel (granulated/pulverised coal) is fed into the firing zone of the kiln through feed holes provided in the kiln roof. The firing zone usually extends up to 8 cars. The temperature in the firing zone is maintained at 900 – 1050°C.
6. There is counter current heat transfer between the bricks and the air. Cold air enters the kiln from the car exit end (6.1) and gets heated while cooling the fired bricks. After combustion, the hot flue gases travel towards the car entrance end losing a part of the heat to the green bricks entering the kiln.
7. Hot air/gases are extracted from the tunnel kiln at several points along the length of the kiln and are supplied to the drying tunnel/chamber. In some of the kilns, there is also provision of a hot air generator to supplement the requirement of hot air for drying.
8. The flue gases from the drying tunnel are released in the atmosphere through a chimney.

07

COMPARATIVE SUMMARY

Snapshot of
brickyard investment
profiles

	TRENCH KILN	STANDARD CLIMBING KILN	MEDIUM CLIMBING KILN	ARTISANAL TUNNEL KILN	UGANDAN KILN
ANNUAL PRODUCTION CAPACITY	400 - 500,000 per year	300 - 400,000 per year	1.5 - 2 million per year	400 - 500,000 per year	750 - 800,000 per year
ENERGY CONSUMPTION	2.5 - 3.0 MJ/Kg Intermittent	2.5 - 2.8 MJ/Kg Intermittent	2.0 - 2.3 MJ/Kg Intermittent	2.5 - 2.8 MJ/Kg Intermittent	2.0 - 2.3 MJ/Kg Intermittent
MACHINES AND EQUIPMENT	MANUAL	MANUAL or MOTORIZED	MANUAL	MANUAL	MANUAL
INFRASTRUCTURE	300 - 400 m ²	300 - 400 m ²	1,200 - 1,500 m ²	300 - 400 m ²	1,000 - 1,200 m ²
WORKFORCE	7 - 10	7 - 10	30 - 50	15 - 20	20 - 28
INVESTMENT REQUIRED	FRW 25 - 30 mio	FRW 16 - 20 mio	FRW 60 - 75 mio	FRW 25 - 30 mio	FRW 50 - 60 mio
EXPECTED ECONOMIC RETURNS	Not recommended for commercial application	Not recommended for commercial application	Not recommended for commercial application	Not recommended for commercial application	Not recommended for commercial application



Early model of a factory with ZigZag Kiln technology deployed in Germany. Factory was in operation for more than 75 years.

HOFFMAN KILN	ZIGZAG KILN S-SIZE	ZIGZAG KILN M-SIZE	ZIGZAG KILN L-SIZE	ZIGZAG KILN XL-SIZE	VERTICAL SHAFT BRICK KILN	INDUSTRIAL TUNNEL KILN
2 - 2.2 million per year	3 - 3.5 million per year	4.8 - 5 million per year	6 - 6.5 million per year	8.5 - 9 million per year	400 - 500,000 per year	25 - 28 million per year
1.5 - 2.0 MJ/Kg Intermittent	1.5 - 2.0 MJ/Kg Intermittent	1.5 - 2.0 MJ/Kg Continuous	1.5 - 2.0 MJ/Kg Continuous	1.5 - 2.0 MJ/Kg Continuous	0.8 - 1.0 MJ/Kg Intermittent	0.8 - 1.0 MJ/Kg Continuous
MANUAL or MOTORIZED	MOTORIZED	MOTORIZED	MOTORIZED	MOTORIZED	MANUAL or MOTORIZED	MOTORIZED
1,500 - 1,800 m ²	2,000 - 2,500 m ²	3,000 - 4,500 m ²	5,000 - 6,000 m ²	7,000 - 8,000 m ²	1,500 m ²	15,000 m ²
25 - 30	40 - 50	60 - 70	70 - 80	100 - 120	15 - 20	150 - 200
USD 150 - 185K	USD 180 - 200 K	USD 300 - 400 K	USD 480 - 580 K	USD 500 - 600 K	USD 45 - 60 K	USD 3 - 4 mio
4.8 yrs payback	3.8 yrs payback	3.3 yrs payback	3.4 yrs payback	3.0 yrs payback	6 - 8 yrs payback	6 - 8 yrs payback

07

ANNEX

Brickyard investment calculation tools

Break-even point

The break-even point is the point at which total cost and total revenue are equal, meaning there is no loss or gain for your small business. In other words, you've reached the level of production at which the costs of production equals the revenues for a product.

Break-even point = Fixed costs + (sales price per unit - variable costs per unit)

Payback period

Payback period in capital budgeting refers to the time required to recoup the funds expended in an investment, or to reach the break-even point.

Payback period = Initial investment / cash flow per year



Former Amagerwa (Kigali, Rwanda) Ugandan kiln with average production capacity of 4 - 4.5 million bricks per year.

Asset depreciation

In accounting terms, depreciation is defined as the reduction of the recorded cost of a fixed asset in a systematic manner until the value of the asset becomes zero or negligible. Depreciation allows a portion of the cost of a fixed asset to the revenue generated by the fixed asset. This is mandatory under the matching principle as revenues are recorded with their associated expenses in the accounting period when the asset is in use. This helps in getting a complete picture of the revenue generation transaction.

Straightline depreciation method:

$\text{Cost of an asset} - \text{Residual value} / \text{Useful life of an asset}$

Diminishing balance method:

$\text{Cost of an asset} * \text{Rate of depreciation} / 100$

Unit of product method:

$(\text{Cost of an asset} - \text{salvage value}) / \text{Useful life in the form of units produced}$

Double declining balance method:

$2 * (\text{beginning value} - \text{salvage value}) / \text{Useful life}$

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