NEW DAWN IN BOTSWANA

RELATOR

Paolo Freda
CEO PEB HOLDING

I represent a young group that has however grown large thanks to the important results that have been achieved in a short time.

Our strength is listening to the client to understand what he needs and adapting our expertise to match his needs as well as those of the market without imposing standardized schemes.

PROJECTENERGYBUSINESS

The Sun is round
It cannot fit your squared box

WHO WE ARE

System integrators
with strong background in

- **EPC CONTRACTING**
- **PROJECT MANAGEMENT**
- **TECHNICAL SERVICE**
- **BOOT PROJECTS**
  (Build Own Operating and Transfer)

WHO WE ARE


England
Milan
Rome
Frosinone
Treviso
Romania
Florida
Zambia

WHAT WE DO

Renewable energies plants:

- **On and off-grid PV plants of any size**
  (ranging from 3 kwp to OVER 1MWp)
- **Solar cooling**
  (using sun to produce AC)
- **Concentrated solar power**
- **Waste to energy processes**
  (bio digestors)

Energy saving procedures for public and private buildings

KEY FACTS AND FIGURES

- **More than 60 mln USD turnover**
- **Renewable energy projects:**
  - Mini-turbine wind farms set up and installed in South Italy
  - 50 small-root-mounted pv plants of about 100 kwp each
- UNI CEI 11352-certified ENERGY saving procedures management
- ISO 9001 for renewable ENERGY plants.
  Design and project management

KEY FACTS AND FIGURES

- **Patented process for photovoltaic modules recycling**
- **Strong partnership with La Sapienza University (ROME) aimed at R&D new projects**
- **KT Tecnimont partnership for waste to energy processes**

WHAT WE KNOW ABOUT BOTSWANA

Economic Sector	GWh
Industry	1463
Transport	0
Residential	927
Commercial and Public Services	762
Agriculture / Forestry	177
Fishing	0
Other non-specified	120
Total Electricity Consumption	**3449**

SOURCE cia world factbook and africa eu cooperation

WHAT WE KNOW ABOUT BOTSWANA

Botswana generation capacity

- Botswana's energy capacity is thermal, mainly coal-fired, with some small diesel generators in rural areas. Almost half of Botswana’s power requirements are imported and only 22% Botswana’s population have access to electricity.

- Although Botswana is ideally suited for solar energy applications, enjoying over 3,200 hours of sunshine per year, its contribution to the national energy balance is irrelevant. Solar energy is currently used for home lighting and water heating, electricity production for telecommunications equipment, and in the rural areas where access to conventional electricity is difficult. Significant business opportunities lie in the manufacture or assembly of solar energy equipment.

WHAT WE KNOW ABOUT BOTSWANA

Power Station	Owner	Installed Capacity (MW)
Morupule A (coal)	BPC	600
Morupule B (coal)	BPC	132
Matshelagabedi (diesel)	BPC	70
Orapa (diesel)	BPC	90
Total		**892**

44% of the country electrical need is imported

Less than 1% of electricity production from renewable sources

(Source bpc 2015 annual report)

WHAT WE KNOW ABOUT BOTSWANA

Energy transmission lines

The CIA World Factbook:

- **population without electricity:** 700,000
- **electrification - total population:** 66%
- **electrification - urban areas:** 75%
- **electrification - rural areas:** 54% (2013)

Why the sun can be the main energy source in ***Botswana***

(source eu pvgis simulation)

Solar capacity of Botswana

Performance of Grid-connect PV

PVGIS estimates of solar electricity generation

- Location : 24°37'41" South, 25°55'23" East, Elevation: 999 m a.s.l.,
- Solar radiation database used: PVGIS-helioclim

- Nominai power of the PV system : 1.0 kW (crystalline silicon)
- Estimated losses due to temperature and low irradiance: 13.2% (using local ambient temperature)
- Estimateci loss due to angular reflectance effects: 2.4%
- Other losses (cables, inverter etc.): 14.0%
- Combined PV system losses : 27.2%

Fixed system: inclination = 28 deg.
Orientation 177 dec. (optimum)

	E_d	E_m	H_d	H_m
Jan	4.59	142	6.50	202
Feb	129	4.60	6.55	181
Mar	4.78	148	6.74	209
Apr	4.71	141	6.44	193
May	4.89	152	6.58	204
Jun	4.79	144	6.26	188
Jul	4.93	153	6.44	199
Aug	5.15	160	6.91	214
Sep	4.93	148	6.81	204
Oct	4.84	150	6.84	212
Nov	451	137	6.50	195
Dec	4.50	140	6.39	198
Year	477	145	6.58	200
		1740		2400

2 – acis tracling system

Month	Ed	Em	H
Jan	7.00	217	9.
Feb	6.60	185	9.
Mar	6.51	202	9.
Apr	6.14	184	8.
May	6.49	201	8.
Jun	6.38	191	8.
Jul	6.55	203	8.
Aug	6.85	212	9.
Sep	6.49	195	8.
Oct	6.76	210	9.
Nov	6.81	204	9.
Dec	7.03	218	10
Year	6.64	202	9.
Total for		2420	

(source eu pvgis simulation)

WHY THE SUN

Fixed system: inclination = 28 cleg.
Orientation 177 dec. (optimum)

Month	E_d	E_m	H_d	H_m
Jan	4.59	142	6.50	202
Feb	129	4.60	6.55	181
Mar	4.78	148	6.74	209
Apr	4.71	141	6.44	193
May	4.89	152	6.58	204
Jun	4.79	144	6.26	188
Jul	4.93	153	6.44	199
Aug	5.15	160	6.91	214
Sep	4.93	148	6.81	204
Oct	4.84	150	6.84	212
Nov	451	137	6.50	195
Dec	4.50	140	6.39	198
Year	477	145	6.58	200
Total for		**1740**		**2400**

2 – acls tracling system

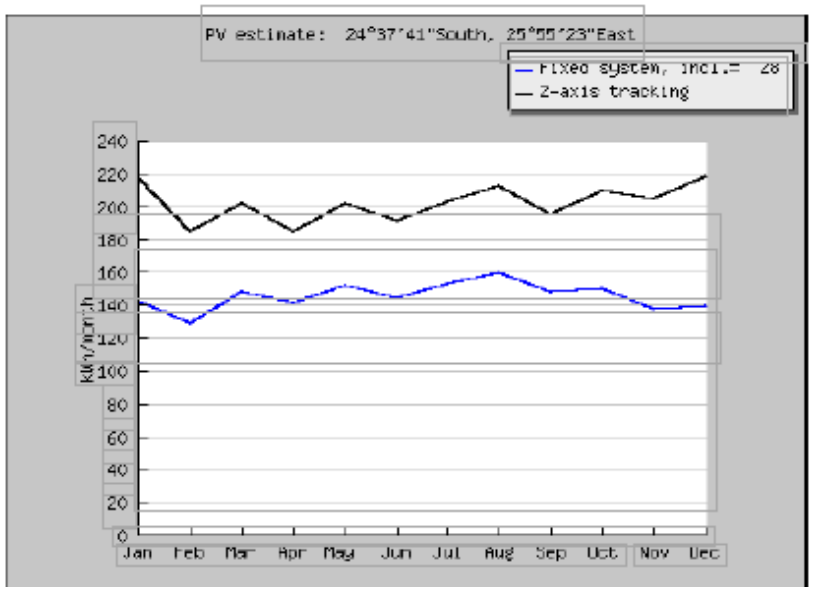
Month	E_d	E_m	H_d	H_m
Jan	7.00	217	9.96	309
Feb	6.60	185	9.44	264
Mar	6.51	202	9.19	285
Apr	6.14	184	8.40	252
May	6.49	201	8.78	272
Jun	6.38	191	8.39	252
Jul	6.55	203	8.60	266
Aug	6.85	212	9.23	286
Sep	6.49	195	8.94	268
Oct	6.76	210	9.56	296
Nov	6.81	204	9.71	291
Dec	7.03	218	10.00	311
Year	6.64	202	9.19	279
Total for		**2420**		**3350**

E_d: Average daily electricity production from the given system (kWh)
E_m: Average monthly electricity production from the given system (kWh)
H_d: Average daily sum of global irradiation per square meter received by the modules of the given system (kWh/m^2)
H_m: Average sum of global irradiation per square meter received by the modules of the given system (kWh/m^2)

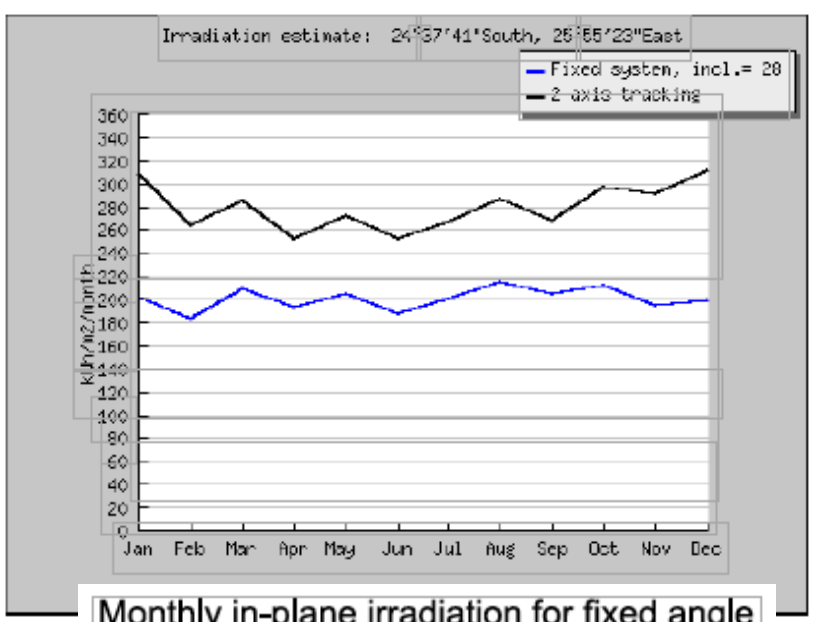
(source eu pvgis simulation)

Solar capacity of Botswana

VERY LOW DISPERSION OF PRODUCTION DUE TO SEASONAL CHANGES



Monthly energy output from fixed-angle PV system



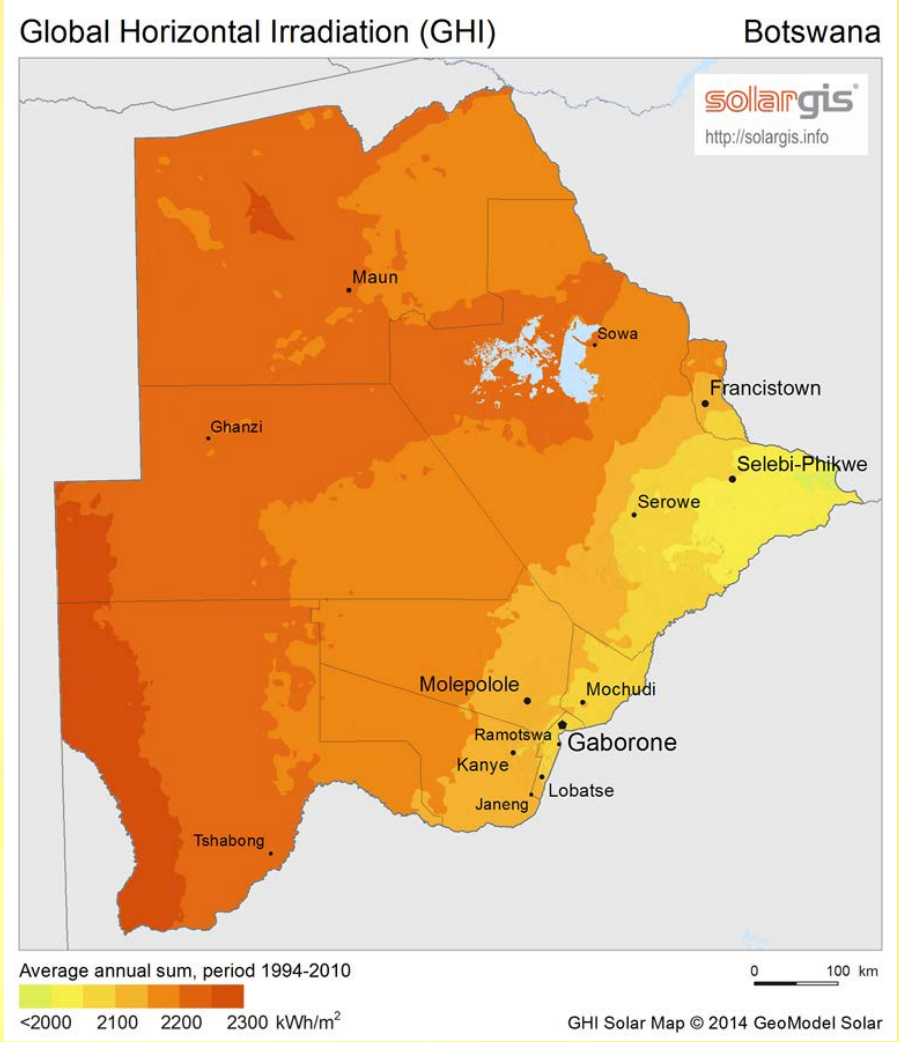
Monthly in-plane irradiation for fixed angle

(source eu pvgis simulation)

WHY THE SUN

Can be the main energy source in Botswana

- **Very steady and consistent energy source**
- **Inexpensive**
- **Technologies using the sun are very reliable now (pv plants have a durability of more than 20 years with almost no maintenance)**



Our proposal

New sun energy for Botswana

SMALL SCALE OFF-GRID PV PLANTS

PROS:

- **easy installation (the come almost ready to use)**
- **battery pack allows use of energy for peaks and/or during the night**
- **each small plant (6 kwp) can power up to 10 houses**

CONS:

- **still relatively expensive**
- **needs third party financing (world bank or eu-africa cooperation)**
- **batteries needs to be replaced every 7/10 years**

BIGGER SCALE PV PLANTS (>1MW)

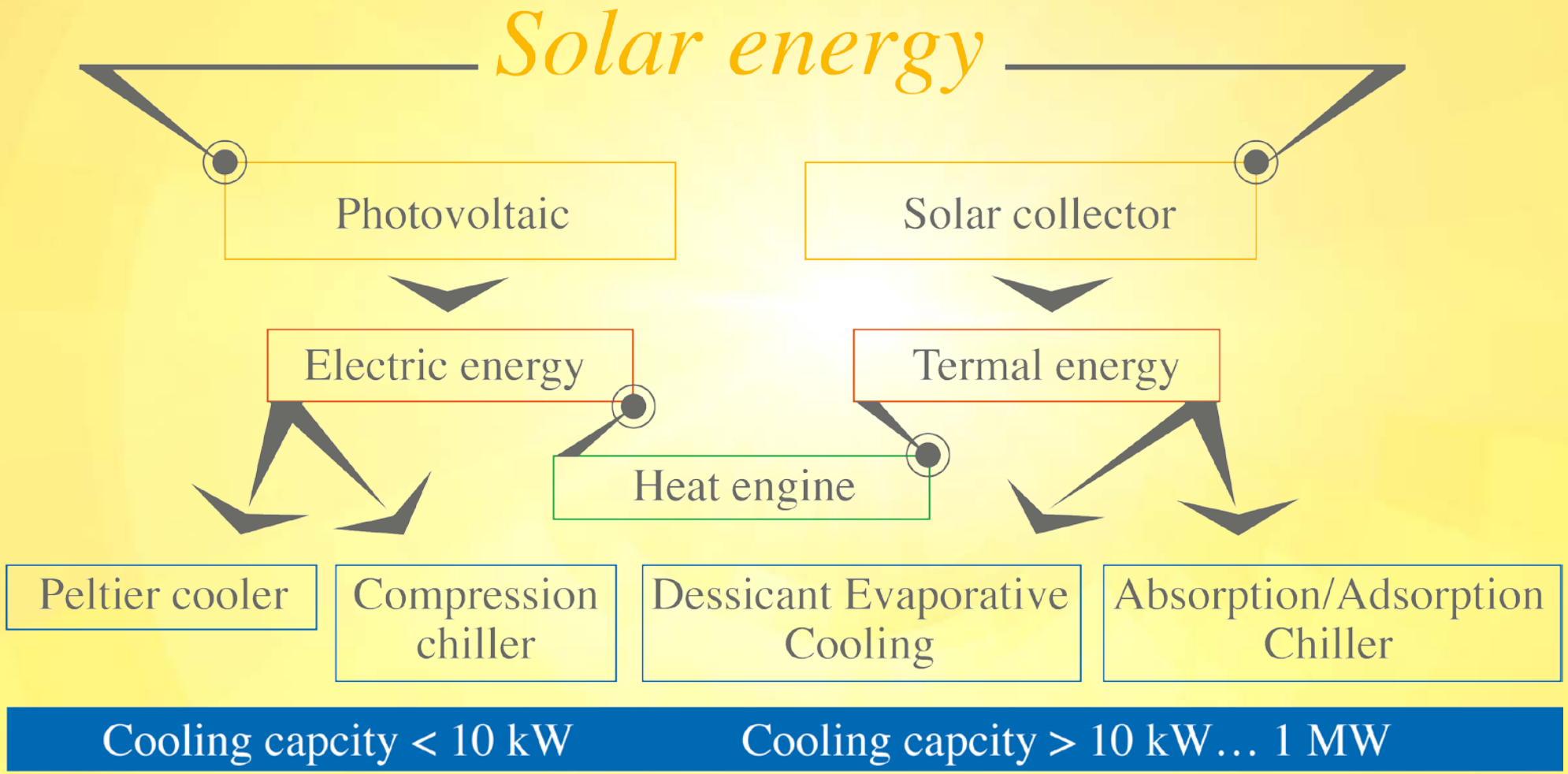
PROS:

- **reliable and tested technology**
- **easy installation with low environmental impact**
- **the can generate on site jobs**
- **the can be upgraded with storage systems that allow the use of energy peaks and/or during nights**

CONS:

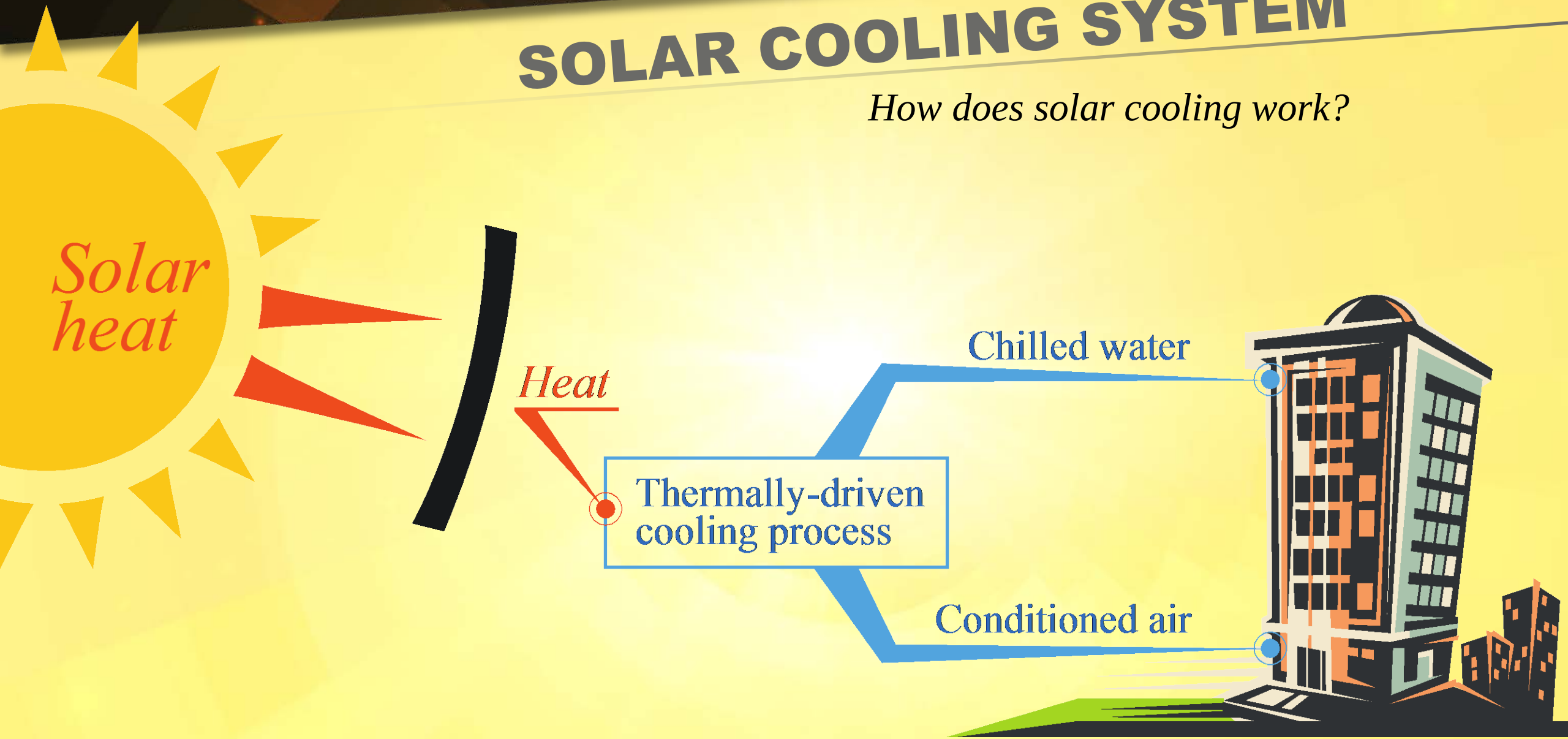
- **expensive therefore the need third party grants**

SOLAR COOLING KEY SCHEME

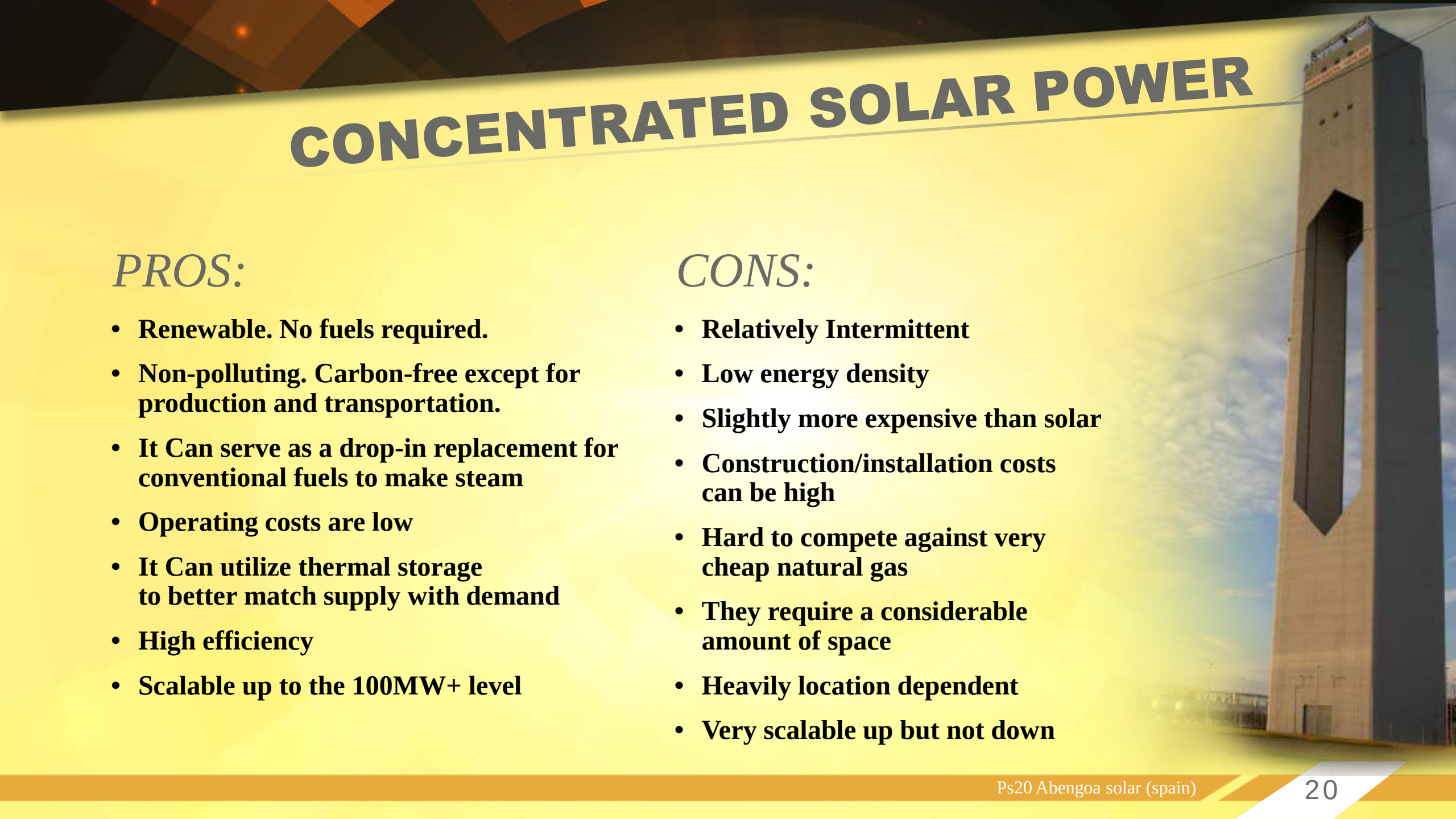


SOLAR COOLING SYSTEM

How does solar cooling work?



CONCENTRATED SOLAR POWER



PROS:

- **Renewable. No fuels required.**
- **Non-polluting. Carbon-free except for production and transportation.**
- **It Can serve as a drop-in replacement for conventional fuels to make steam**
- **Operating costs are low**
- **It Can utilize thermal storage to better match supply with demand**
- **High efficiency**
- **Scalable up to the 100MW+ level**

CONS:

- **Relatively Intermittent**
- **Low energy density**
- **Slightly more expensive than solar**
- **Construction/installation costs can be high**
- **Hard to compete against very cheap natural gas**
- **They require a considerable amount of space**
- **Heavily location dependent**
- **Very scalable up but not down**

Let’s make Botswana energetically indipendent and ***RENEWABLE***

Together we can do it