



CCS - Africa

CCS: A Capacity Building Effort in Africa



CARBON CAPTURE AND STORAGE IN BOTSWANA

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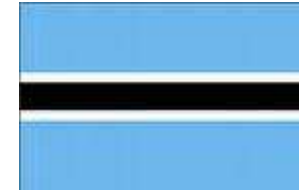
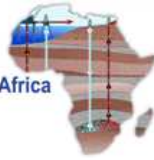
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OUTLINE

- DEVELOPMENT –STATUS AND OBJECTIVES
- IMPERATIVES AND PROSPECTS FOR CCS
- STAKEHOLDER INPUTS

DEVELOPMENT- STATUS AND OBJECTIVES



● **BACKGROUND**

- **LARGE COUNTRY WITH SPARSELY POPULATED AREAS
1.9MILLION ON 582000 KM2; 80% IN 20% OF SE; 50% OF
POPULATION WITHIN 100KM OF GABORONE.**
- **A COUNTRY THAT HAS ENJOYED IMPRESSIVE ECONOMIC
GROWTH (9%/YR) IN THE LAST 4 DECADES PER CAPITA~
\$7000 SUPPORTED BY VIBRANT MINING INDUSTRY
MAINLY DIAMONDS- MINING CONTRIBUTE 40% TO GDP!**
- **CHALLENGED BY DIAMOND SUPPORTED ECONOMY**
- **POVERTY (~30%), INEQUAITY (5th Globally),
UNEMPLOYMENT (>20%) AND HIGH INCIDENCE OF
HIV/AIDS**
- **.Global financial crisis has not spared Botswana with diamond
industry affected –fallen by 73%. Expected to return to 2008 pre-
crisis level by 2012.**



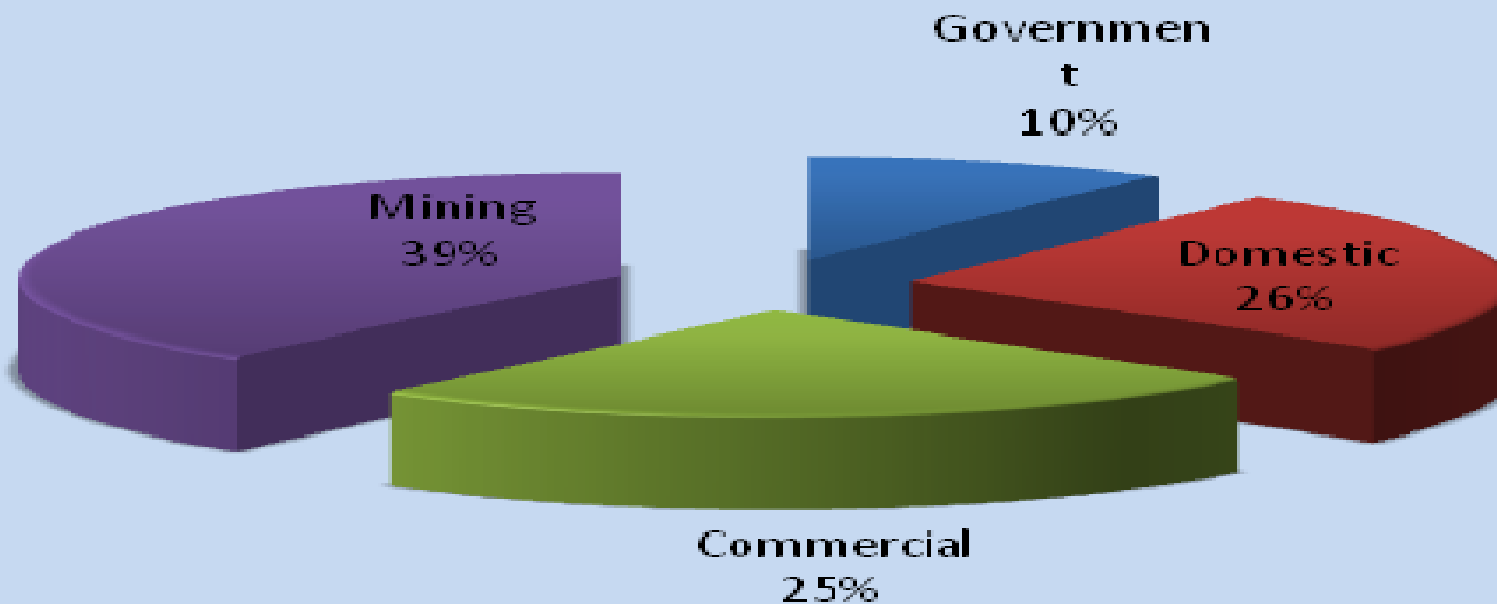
- **DEVELOPMENT OBJECTIVES**
- **WANTING TO DIVERSIFY THE ECONOMY** (identifying new engines of growth)- among them Coal and gas energy base with support industries and activities
- **POVERTY REDUCTION STRATEGIES**

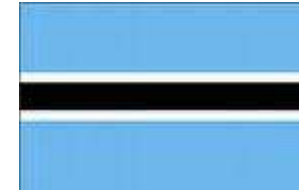
IMPERATIVES AND PROSPECTS



Diversification to non mining sector coming with increased electricity demand.

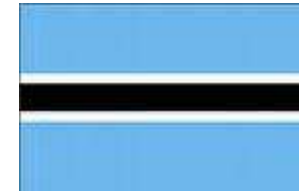
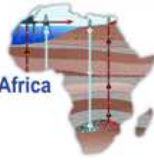
Figure1: Botswana Electricity (kWh)Sales by Sector- 2009





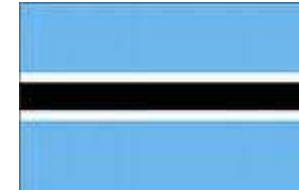
ENERGY SECURITY SITUATION

- CURRENTLY BOTSWANA IMPORTS ~80% FROM SA AND OTHER SAPP COUNTRIES.
- DEMAND EXPECTED TO INCREASE FROM ~517MW (peak) in 2008/09 to 613 MW BY 2013; 850MW by 2017 and 1130 MW by 2026.
- Deficit 18% in 2009 to 83% in 2013 before new generation capacity comes on stream
- NO EXCESS POWER IN THE REGION FOR FURTHER IMPORTS. Imports increasingly getting costly from US\$2 until 2007 to US\$5/Kwh by now 2010.
- Imports also uncertain at best due to exporters national interests and transmission hiccups. (SA also had a shortfall of 700MW in 2007!)
- BOTSWANA HAS AN AMBITIOUS TARGET OF ELECTRIFICATION CONNECTIVITY OF 80% BY 2016 from a current 55%



RESTRAINED POWER SUPPLY SITUATION

| Source | Quantum | Remarks |
|-------------------------------|----------------|--|
| Morupule Power Station | 120MW | Normally operating at 90MW |
| Eskom () | 410 MW - 2007 | 5 Year Stepped Reduction Mandatory 10% reduction on 2007 profile. (Maximum Import limited to 315MW) |
| | 350 MW - 2008 | |
| | 350 MW - 2009 | |
| | 250MW - 2010 | |
| | 150MW - 2011 | |
| | 150MW - 2012 | |
| HCB | Upto 50MW/75MW | 1 Year renewable agreement (Not firm) |
| EDM | Upto 40MW | 1 Year renewable agreement (Not firm). Not available at peak (17:00-22:00hrs) |



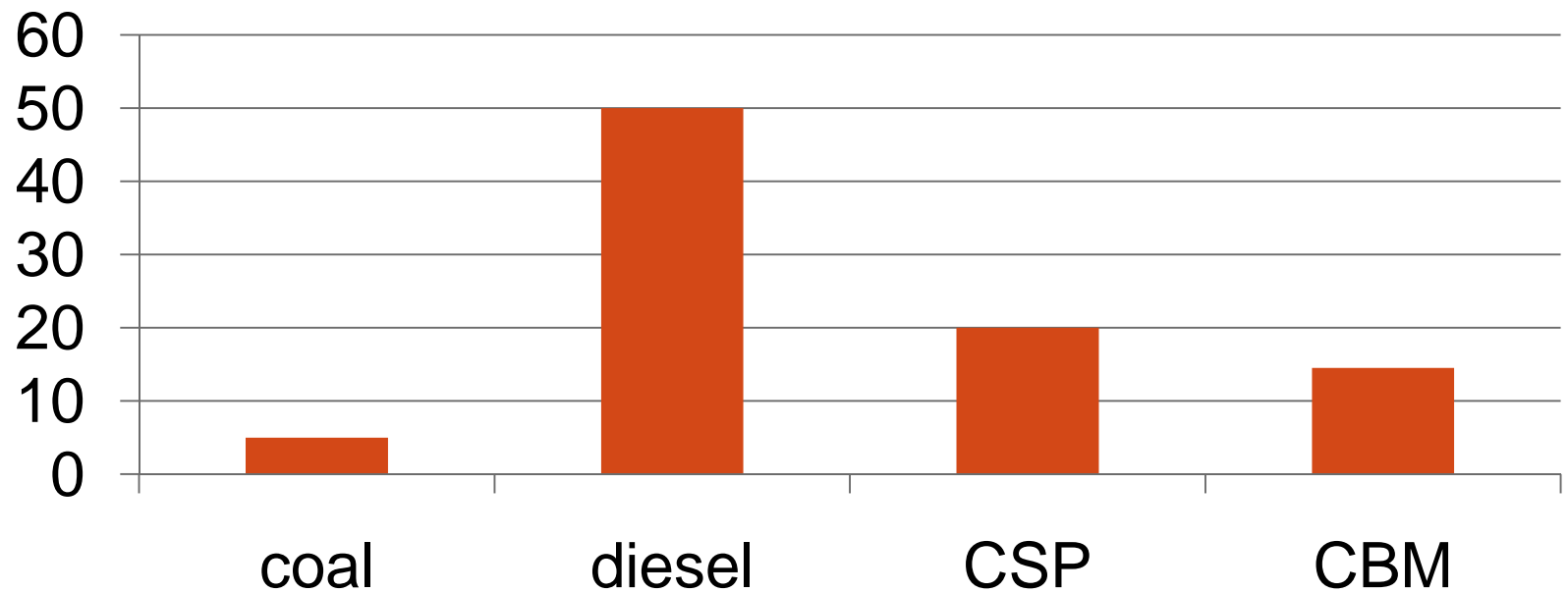
WHAT IS THERE AND WITHERTO

| option | availability (MW) | remarks |
|-------------------------------|---|---|
| EXISTING COAL- Morupule A | 90 net | to be retired 2020 |
| Diesel units | 160 9 (70MW GOVT AND 90MW GOVT AND DEBSWANAN | short term gap fill only |
| comncentrating solar power | upto 200 MW by 2020 | 50MW targeted by 2016 but needs dionor support |
| Coal Bed Methane | 200MW by 2020n 50MW likely by 2015/16 | tapping resourice still to start |
| New Coal Power plants | upto 3000MW- as per SAPP | need 4 year lead time |



Cost of supply

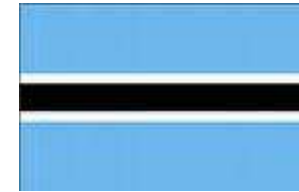
Cost of generation (Usc/Kwh)





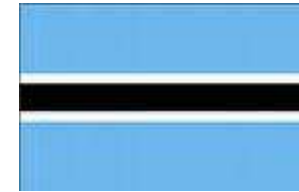
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FUTURE SUPPLY

- **COAL** ~~LEAST COST~~ **BEST OPTION**
- LARGE RESOURCE BASE ~200 BILLION TONNES
- UNTAPPED RESOURCE CURRENTLY (900,000 T MINED NOW- 5 BILLION TONNES MINEABLE AT Morupule alone.
- CAN ALSO SUPPLY REGION WITH COAL BASED POWER- A DIVERSIFICATION ELEMENT
- **CBM** ALSO SECOND BEST OPTION- COST WISE.
- ALSO HUGE INFERRED RESOURCE BASE 190 TCF- LARGEST gas DISCOVERY IN REGION THAT CAN TRANSFORM ENERGY AND INDUSTRY IN THE REGION even at 10-15% use..,
- BOTH COAL AND GAS HENCE provide diversification option for Botswana



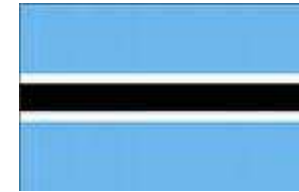
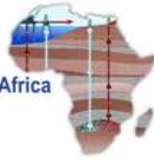
SOME INTERESTING FIGURES

[1] 1 TCF can supply a 1000MW for 25 years (ESKOM pers comm..). Botswana is estimated to have 28 TCF of coal bed methane.

[1] US\$ 8/GJ SASOL gas compared to USD36/GJ of diesel. Coal Bed Methane can be delivered at US\$2.GJ at Morupule

[1] These are derived from the calorific value of diesel and the pump price of diesel versus the calorific value of Methane and a cost for LNG

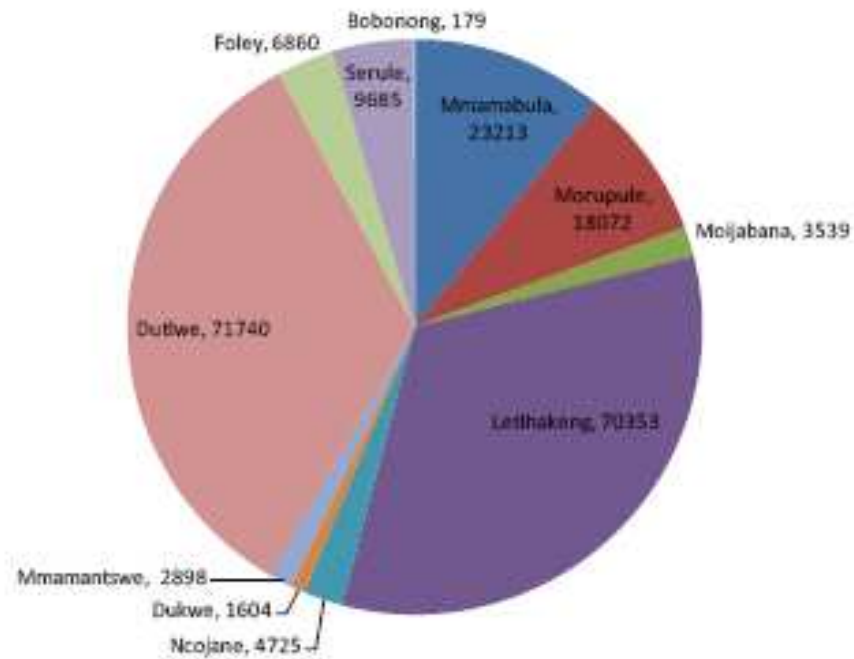
[1] 90 % of all US CBM production is delivered from wells shallower than 800 m below ground level. From previously clearly defined coal fields. Other gas wells are between 1500 m to 3500m below ground level INCREASING COSTS OF SUPPLY.



Coal Resources of Botswana in mt

From DGS, Chatupa 1981 (Reviewed by Barlow Jonker)

Total (All categories) 212,868mt



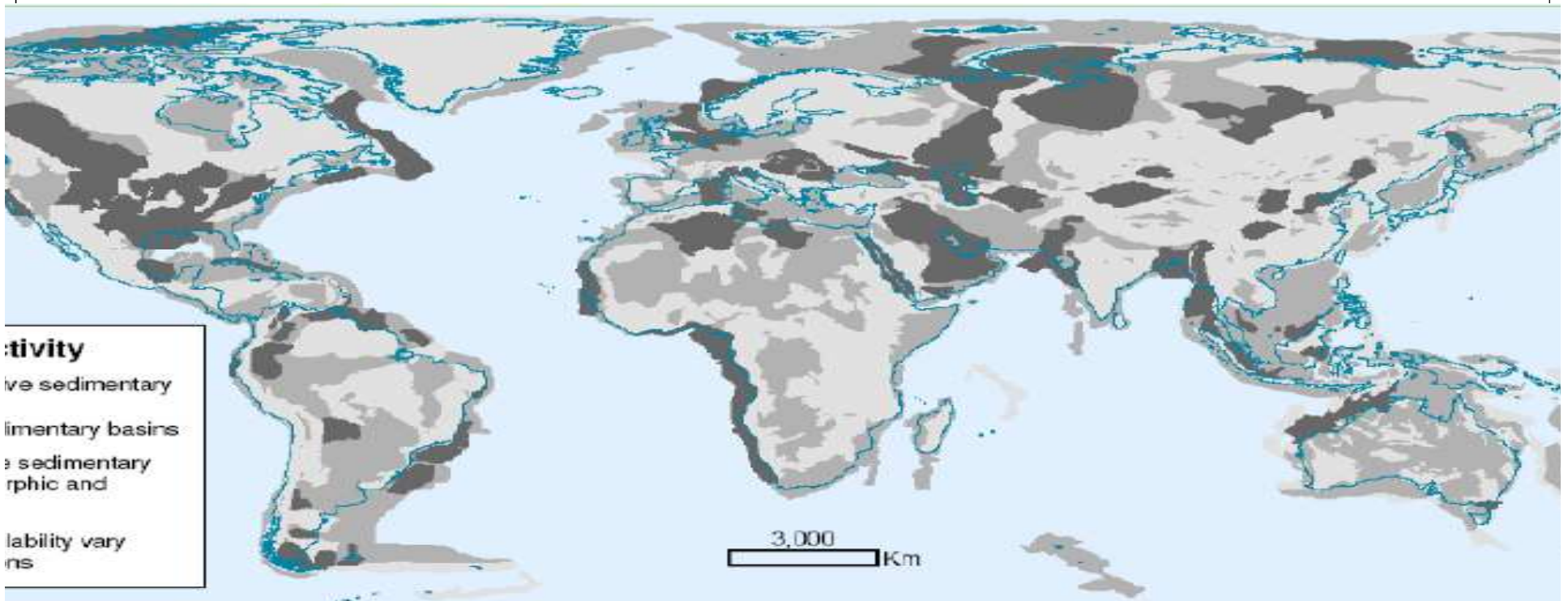
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IPCC 2005

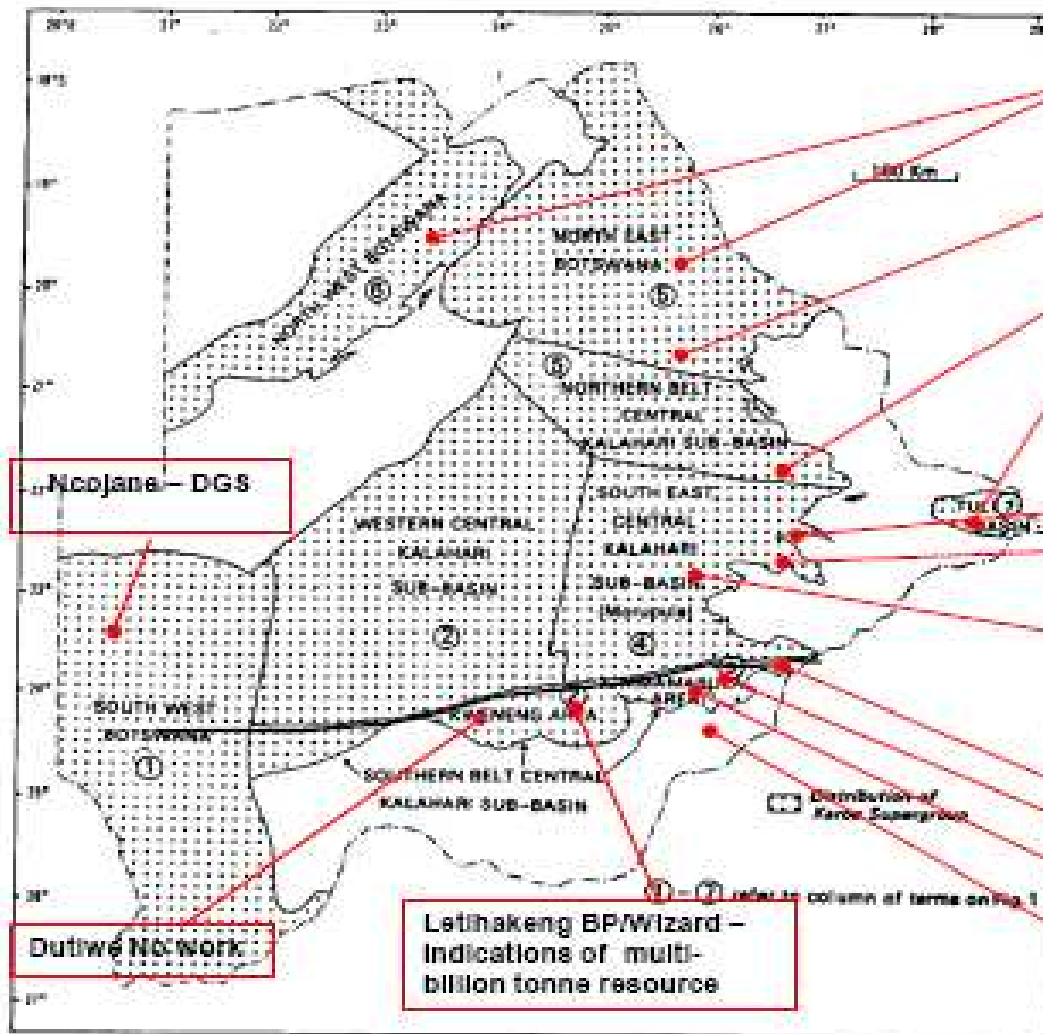


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Source: IPCC

KAROO AND COALFIELDS AND CURRENT GAS EXPLORATION

Exploration work and results since 2000's



Ncojane – DGS

Dutwe No work

Lethakeng BP/Wizard –
Indications of multi-
billion tonne resource

- Pandamatenga and Maun – CBM work by Anglo Coal and Zulu Energy
- Dutwe & Sowa – AEB and Daheng. >1Bt resource confirmed
- Foley/Serule – No work undertaken
- Bobonong - Talk of exploration work but DWA water exploration has indicated Upper Karoo on basement
- Lachana/Tshimoyapula - Total & AEB >1Bt resource
- Morupula/Kgaswe - Shell Coal/MCL >10Bt resource confirmed
- Moljabana /Moshoro – Shell Coal/AEB/Jaguar Ventures – Indications of multi-billion tonne resource. KalGas/Sabre CBM Exploration Programme
- Mmamabula East - BP/CIC 2.6 Bt resource and growing
NC - Shell Coal/CdF/Magalong >0.5Bt Resource
West – CdF/AEB >2Bt resource
- Mmamantse Aviva- >1Bt resource

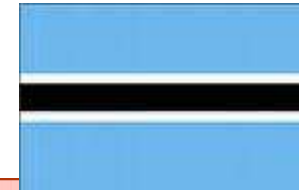


DILEMMA

- 1994 GHG EMISSIONS FROM POPWER
Generation 1750 Gg when installed capacity 132MW
- increase to 1800MW expected to increase GHG emissions by 15 fold
- 3000MW and 200MW CBM will further increase emissions
- For such huge coal and CBM resource potential- best to plan a clean energy development path.
- Whilst other cleaner options exist- seen that they are costly and may not meet base load soon.
- Option available to use coal is combined with CCS
- **CCS ALSO ADDED ADVANTAGE IN EXPLOITATION**



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Technology Maturity Level (source – www.ieagreen.org.uk)

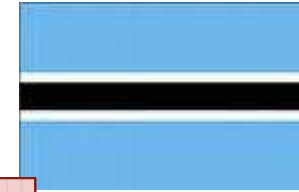
| CCS component | CCS Technology | Research Phase | Demo Phase | Economic feasibility | Maturity |
|------------------------|-----------------------|----------------|------------|----------------------|----------|
| Capture | Post combustion | | | | |
| | Pre-combustion | | | | |
| | Oxyfuel combustion | | | | |
| | Industrial separation | | | | |
| Transportation | Pipeline | | | | |
| | Shipping | | | | |
| Geological Storage | Enhanced oil recovery | | | | |
| | Gas and oil fields | | | | |
| | Saline formations | | | | |
| | Enhanced CBM recovery | | | | |
| Industrial uses of CO2 | | | | | |



BOTSWANA EXPERIENCE WITH CCS

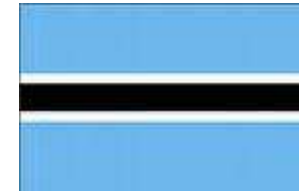
- NOT A NOVICE
- SASOL INITIATIVE
- PARTICIPATION IN CCS Africa workshop 2007
- IPP planning CCS ready plant
- World Bank pledging support for pilot CCS
- Botswana also mentioned CCS for continued coal use as one of its NAMAs together with EE, shift from coal to gas, RE and biomass based power generation, nuclear.

STAKEHOLDER INPUTS



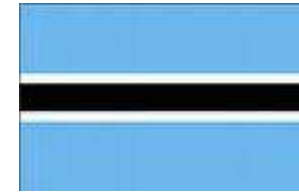
STAKEHOLDER SURVEY

- familiarity with CCS
- How CCS is relevant to stakeholder
- Any initiatives known to be happening
- Any prospects for CCS in Botswana
- important issues to address for ccs to happen
- Important issues to discuss at workshop
- who to be involved



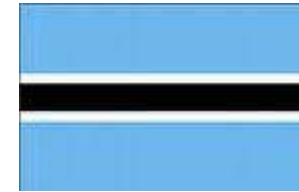
familiarity with CCS

- -SUPERFICIAL- NO PAST PARTICIPATION
- KNOW GOVT PARTICIPATION IN SASOL PROJECT
- FIRST EXPERIENCE
- NONE APART FROM THAT IT PREVENTS ENVIRONMENTAL POLLUTION
- NOTHING
- AT COP SIDE EVENT- UNFCCC INITIATIVE
- WROTE A PAPER ON CCS BUT NOT PARTICIPATED IN ANY CCS EVENTS.
- NO PARTICIPATION-ONLY KNOWLEDGE THAT CCS IS PRACTISED IN EUROPE



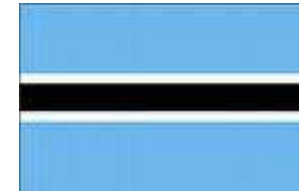
Prospects of CCS in Botswana

- Yes we are a coal rich country and we need to develop this resource
- Yes because Botswana has huge low grade coal reserves that can absorb CO₂ and accordingly enhance CBM production but will need informed parties to support this.
- NO due to financial constraints
- Yes because of such initiatives
- Yes but will depend on geological potential for storage
- may need to be combined with new coal burning technology.
- Yes since country is still developing and many projects based on fossil fuel are in pipeline



Issues that need to be addressed for CCS to happen

- Research on clean coal and how to alter CO₂ to something useful
- Create enabling legislation and institutional framework
- Substantial investment and industrialization
- Funding
- Education of the people and research on geological structures
- Suitable storage economics



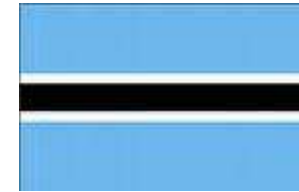
What issues to discuss at workshop

- What is CCS, experiences and results and alternatives to CCS
- Incentives to investors to fund CCS projects
- How to administer CCS initiatives
- Impact of storage on water systems due gas leakage and other impacts
- Appreciation of new clean coal technology, economics and storage.
- Awareness on CCS, Botswana position on CCS



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- **PROPOSED FOLLOW-UP**

- - Need for more awareness to get buy-in from both Govt and public – partly purpose of this workshop & CCS Africa 2 in general
- private sector would want to move forward fast- will require a CCS regulatory framework and commercialization of CBM industry.- ONE OF OBJECTIVES OF CCS-AFRICA2
- Defining areas with potential storage-ONE OF OBJECTIVES OF ccs-Africa2- QUICK SCAN



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THANK YOU

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