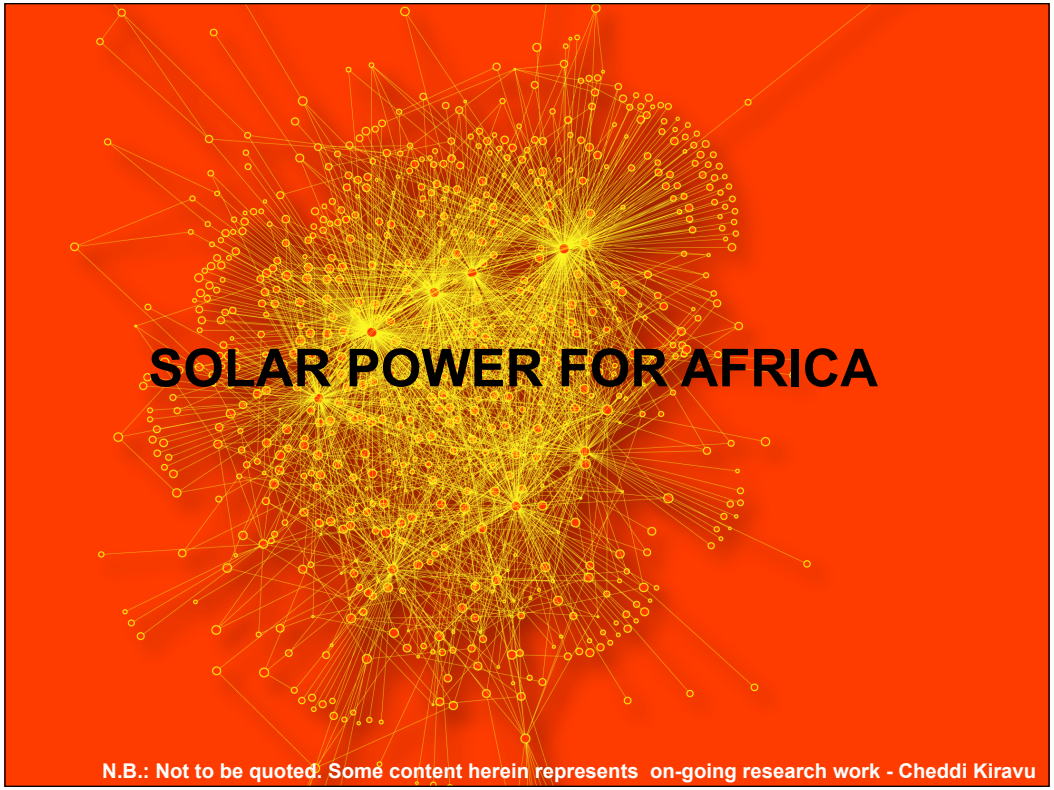

SOLAR POWER FOR AFRICA
N.B.: Not to be quoted. Some content herein represents on-going research work - Cheddi Kiravu

UNIVERSITY OF BOTSWANA

ASSESSING THE READINESS FOR PV TECHNOLOGY (PVT) ADOPTION IN HOUSEHOLDS USING AGENT-BASED MODELING AND SIMULATION (ABMS)

By Cheddi Kiravu

WHAT IS IN THE TERM "READINESS"?

1. TECHNOLOGICAL READINESS
   - IS THERE GENERAL TECHNOLOGY AWARENESS?
   - IS THE NEAR/LONG-TERM PERSONAL GOOD OF PVT UNDERSTOOD?
     - DIRECT FINANCIAL GAINS - LIFE-CYCLE SAVINGS
     - BENEFITS OF ACHIEVED MILLENNIUM DEVELOPMENT GOALS (MDGs)

   ARE THE WIDER PUBLIC-GOOD OF PVT UNDERSTOOD?
   - REDUCTION IN COUNTRY'S ENERGY SYSTEM DEMAND
   - IMPROVEMENT OF COUNTRY'S ENERGY SECURITY
   - ENVIRONMENTAL PROTECTION DUE TO REDUCED GHG EMISSIONS
   - ECONOMIC DIVERSIFICATION & SECURITY

2. INSTITUTIONAL READINESS
   - ARE INSTITUTIONAL ARRANGEMENTS IN PLACE FOR PVT BUSINESS?
   - IS THE MARKET PENETRATION OF PVT GUARANTEED BY POLICY, REGULATIONS, AND GUIDELINES?
   - ARE CHANNELS OF COMMUNICATING AWARENESS EFFECTIVE?

PRESENTATION OUTLINE

1. INTRODUCTION: RURAL DEVELOPMENT VIS-A-VIS ENERGY ACCESS
   - HUMAN DEVELOPMENT INDEX (HDI)
   - MILLENNIUM DEVELOPMENT GOALS (MDGS)
   - ENERGY ACCESS VS MILLENNIUM DEVELOPMENT GOALS

2. BACKGROUND: WHAT IS THE PROBLEM? IS PV ADOPTION AN ISSUE?

3. PROPOSED FRAMEWORK FOR SUSTAINING PV CHOICE-DECISIONS
   - THE AGENT-BASED MODELING PARADIGM
   - PROPOSED AGENT-BASED SOLAR PV ADOPTION NETWORK MODEL

4. EXPECTED OUTCOME AND REFLECTION ON RENEWABLE ENERGY POLICY

5. CONCLUSIONS: BARRIERS TO PVT DIFFUSION AND POSSIBLE LESSONS

1. ROLE OF ACCESS TO ENERGY SERVICES IN RURAL DEVELOPMENT

WHAT IS DEVELOPMENT? WHICH YARDSTICK? HOW ABOUT THE GDP?

PONDER OVER A METRIC THAT ACCOUNTS FOR THE AVAILABILITY OF CLEAN WATER, DECENT HOUSING, PRIMARY EDUCATION, HEALTH CARE, GENDER EQUALITY, STATE OF HUNGER, DEMOCRATIC PARTICIPATION, ETC.

THESE YARDSTICKS MEASURE DIRECTLY HUMAN DEVELOPMENT. THE RESULTING METRIC IS TERMED,
HUMAN DEVELOPMENT INDEX (HDI)

Interesting interactive HDI data found here:

http://hdr.undp.org/en/data/build/

The interpretation of HDI found here:

http://hdr.undp.org/en/media/

THE HUMAN DEVELOPMENT INDEX - A CLOSER LOOK

THE INDEX ASSESSES THE STRIDES THAT COUNTRIES HAVE MADE IN THE FOLLOWING ASPECTS OF HUMAN DEVELOPMENT

(Source: http://hdr.undp.org/en/**)**

- ☑ Health
- ☑ Education
- ☑ Income
- ☑ Inequality
- ☑ Poverty
- ☑ Gender
- ☑ Sustainability
- ☑ Human Security

ACHIEVEMENT OF HIGH HDIs THROUGH THE MILLENNIUM DEVELOPMENT GOALS - MDGs

THE 8 MDGs SPECIFY SPECIFIC DEVELOPMENT TARGETS TO BE ACHIEVED BY THE YEAR 2015.

The World Bank lists the 8 MDGs and country performances here:
http://www.worldbank.org/mdgs/

The official list of the MDGs, Targets, and Indicators is found here:
http://siteresources.worldbank.org/DATASTATISTICS/Resources/MDGsOfficialList2008.pdf

An interesting, interactive eAtlas of the MDGs is found here:
http://data.worldbank.org/

MDGs

1. ERADICATE EXTREME POVERTY AND HUNGER
2. ACHIEVE UNIVERSAL PRIMARY EDUCATION
3. PROMOTE GENDER EQUALITY AND EMPOWER WOMEN
4. REDUCE CHILD MORTALITY
5. IMPROVE MATERNAL HEALTH
6. COMBAT HIVE/AIDS, MALARIA, AND OTHER DISEASES
7. ENSURE ENVIRONMENTAL SUSTAINABILITY
8. DEVELOP A GLOBAL PARTNERSHIP FOR DEVELOPMENT

MDGs, TARGETS, AND PROGRESS-MONITORING INDICATORS

Official targets and matching indicators of the 8 MDGs are found here:

http://siteresources.worldbank.org/DATASTATISTICS/Resources/MDGsOfficialList2008

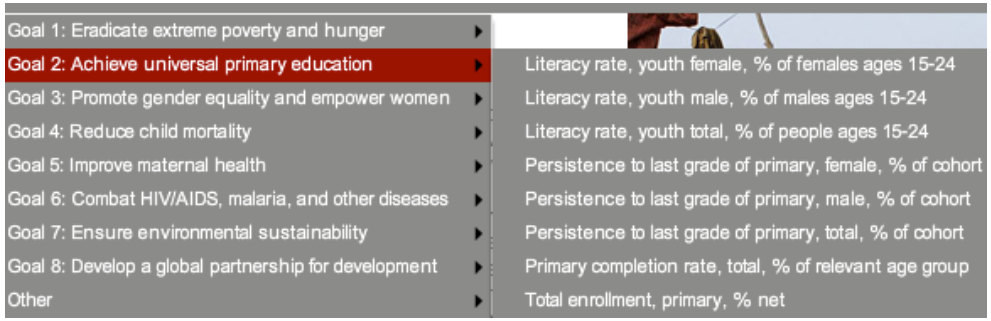
Millennium Development Goals (MDGs)	
Goals and Targets (from the Millennium Declaration)	**Indicators for monitoring progress**
Goal 1: Eradicate extreme poverty and hunger	
Target 1.A: Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day	1.1 Proportion of population below $1 (PPP) per day[a] 1.2 Poverty gap ratio 1.3 Share of poorest quintile in national consumption
Target 1.B: Achieve full and productive employment and decent work for all, including women and young people	1.4 Growth rate of GDP per person employed 1.5 Employment-to-population ratio 1.6 Proportion of employed people living below $1 (PPP) per day 1.7 Proportion of own-account and contributing family workers in total employment
Target 1.C: Halve, between 1990 and 2015, the proportion of people who suffer from hunger	1.8 Prevalence of underweight children under-five years of age 1.9 Proportion of population below minimum level of dietary energy consumption
Goal 2: Achieve universal primary education	
Target 2.A: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	2.1 Net enrolment ratio in primary education 2.2 Proportion of pupils starting grade 1 who reach last grade of primary 2.3 Literacy rate of 15-24 year-olds, women and men
Goal 3: Promote gender equality and empower women	
Target 3.A: Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015	3.1 Ratios of girls to boys in primary, secondary and tertiary education 3.2 Share of women in wage employment in the non-agricultural sector 3.3 Proportion of seats held by women in national parliament

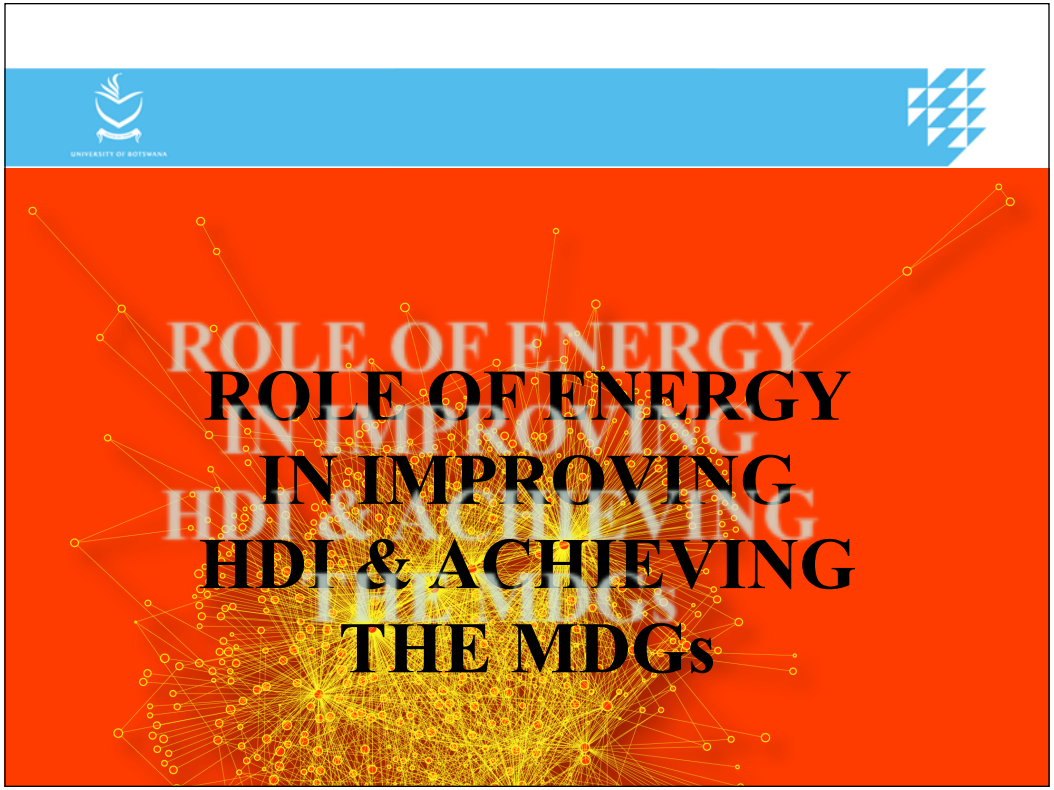
CAUTION! MDG INDICATORS Vs WD INDICATORS

THE MDG INDICATORS ARE NOT SYNONYMOUS WITH THE WORLD DEVELOPMENT INDICATORS (WDI) FOUND HERE:

http://www.app.collinsindicate.com/mdg/en/

http://data.worldbank.org/indicator



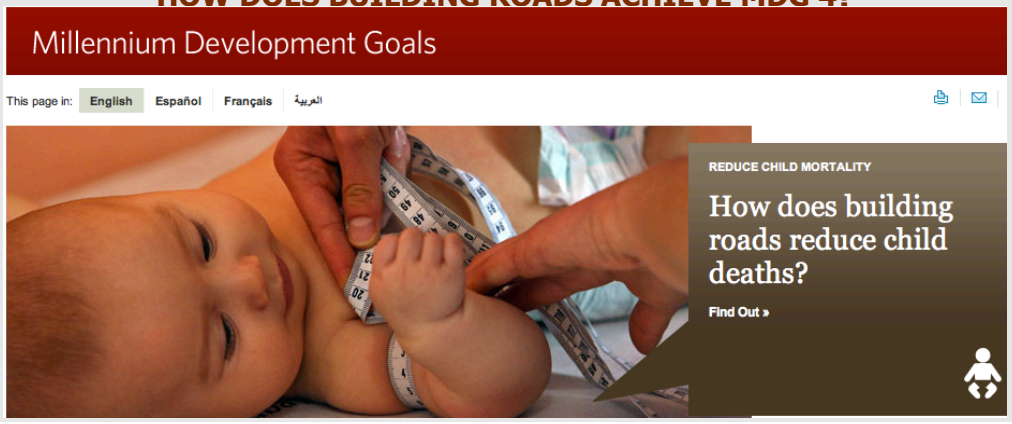

ROLE OF ENERGY
IN IMPROVING
HDI & ACHIEVING
THE MDGs

HDI RANKINGS FOR AFRICAN COUNTRIES

THE MDGs ARE CLOSELY LINKED: THE ACHIEVEMENT OF ONE ENABLES THE ACHIEVEMENT OF ANOTHER. ACCESS TO ENERGY SERVICES IS CENTRAL IN ACHIEVING MOST MDGs.

EXAMPLE: IS ACCESS TO ENERGY CENTRAL TO BUILDING ROADS?

HOW DOES BUILDING ROADS ACHIEVE MDG 4?



NEED TO IMPROVE THE HDI AND HELP ACHIEVE THE MDGs IN AFRICA

IT IS ACKNOWLEDGED
THAT A DIRECT RELATIONSHIP EXISTS BETWEEN
THE PROVISION OF ENERGY SERVICES
AND THE ATTAINMENT OF THE MDGs.
THIS LINKAGE IS INEXTRICABLE!

WHAT ROLE CAN ACCESS TO ENERGY SERVICES PLAY IN THE AFRICAN QUEST TO ACHIEVE THE MDGs?

N.B.: THE MDGs ARE CLOSELY LINKED: THE ACHIEVEMENT OF ONE MAY LEAD DIRECTLY TO OUR ABILITY TO ACHIEVE ANOTHER. ACCESS TO ENERGY SERVICES MAY INDIRECTLY CONTRIBUTE TO THE ACHIEVEMENT OF A PARTICULAR MDG.

ROLE OF ENERGY ACCESS IN ACHIEVING THE MDGs - DISCUSSION I

HOW CAN SUSTAINABLE ENERGY SUPPORT INCOME-GENERATING ACTIVITIES IN THE RURAL AREAS?

AND HOW DOES INCOME-GENERATING ACTIVITIES HELP ACHIEVE MDG 1? WHAT OTHER WAYS CAN ENERGY HELP ACHIEVE MDG 1?

Millennium Development Goals

This page in: English Español Français العربية

ROLE OF ENERGY ACCESS IN ACHIEVING THE MDGs - DISCUSSION II

HOW CAN ACCESS TO ENERGY SERVICES SUPPORT AND BOOST AGRICULTURAL ACTIVITIES?

AND HOW IMPROVED FOOD SECURITY BE LINKED TO ACHIEVEMENT OF MDG 1? DISCUSS

ROLE OF ENERGY ACCESS IN ACHIEVING THE MDGs - DISCUSSION III

HOW CAN ACCESS TO ENERGY SERVICES IMPROVE HEALTH SERVICES IN THE RURAL AREAS AND, MATERNAL HEALTH IN PARTICULAR?

AND HOW CAN IMPROVED MATERNAL HEALTH REDUCE POVERTY THEREBY IMPLEMENTING MDG 1?

Millennium Development Goals

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ROLE OF ENERGY ACCESS IN ACHIEVING THE MDGs - DISCUSSION IV

HOW DOES ACCESS TO ENERGY SERVICES HELP ACHIEVE MDG 2 - UNIVERSAL PRIMARY EDUCATION ?

AND HOW DOES ACHIEVING MDG 2 THEN IMPROVE THE HEALTH OF MOTHERS AND THEIR CHILDREN?

Millennium Development Goals

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ROLE OF ENERGY ACCESS IN ACHIEVING THE MDGs - DISCUSSION V

HOW ABOUT GENDER EQUALITY AND WOMEN EMPOWERMENT - MDG3? CONSIDERING HOUSE CHORES IN A VILLAGE SETTING HOW CAN ACCESS TO ENERGY IMPROVE AFRICAN WOMEN SITUATION? AND HOW DOES THIS IN TURN PROMOTE ECONOMIC STABILITY? EQUALITY OF OPPORTUNITIES? TIME FREEDOM ETC?

Millennium Development Goals

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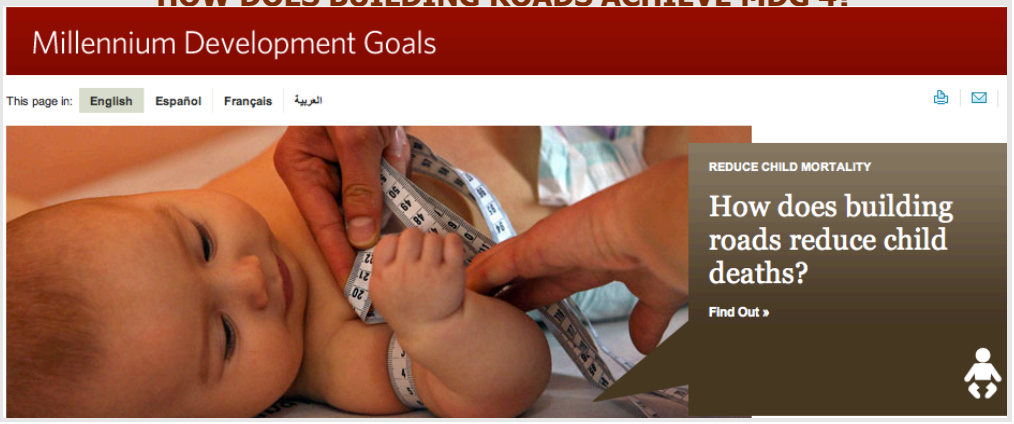
ROLE OF ENERGY ACCESS IN ACHIEVING THE MDGs - DISCUSSION VI

MDG 4 TARGETS THE REDUCTION OF CHILD MORTALITY. IN WHAT VARIOUS WAYS CAN THE PROVISION OF ENERGY SERVICES IN THE RURAL AREAS SUPPORT THIS MDG?

EXAMPLE: IS ACCESS TO ENERGY CENTRAL TO BUILDING ROADS?

HOW DOES BUILDING ROADS ACHIEVE MDG 4?



ROLE OF ENERGY ACCESS IN ACHIEVING THE MDGs - DISCUSSION VII

HOW DOES ACCESS TO ENERGY SERVICES PREVENT THE ONSET OF DISEASES -MDG6? IMPROVE MATERNAL HEALTH -MDG5? REDUCE CHILD MORTALITY - MDG4? COMBAT HIV/AIDS, MALARIA, AND OTHER DISEASES -MDG6?

AND HOW THE ABOVE CONTRIBUTE TO STABLE GOVERNANCE?

Millennium Development Goals

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ROLE OF ENERGY ACCESS IN ACHIEVING MDG 7 - DISCUSSION VIII

DISCUSS HOW ACCESS TO ENERGY SERVICES ENSURES ENVIRONMENTAL SUSTAINABILITY IN THE LIGHT OF THE FOLLOWING PRINCIPLE OF SUSTAINABLE DEVELOPMENT:

"SUSTAINABLE DEVELOPMENT
IS A PROCESS OF DEVELOPMENT IN WHICH
THE EXPLOITATION OF RESOURCES, DIRECTION OF INVESTMENTS,
ORIENTATION OF TECHNOLOGIES, INSTITUTIONAL CHANGES,
ARE ALL IN HARMONY AND ENHANCE BOTH CURRENT AND FUTURE
POTENTIAL TO MEET HUMAN NEEDS AND ASPIRATIONS"
Brundtland, "Our Common Future", 1987 "

ROLE OF ENERGY ACCESS IN ACHIEVING MDG 7 - DISCUSSION VIII

IN PARTICULAR DISCUSS:

HOW THE INTEGRATION OF THE PRINCIPLES OF SUSTAINABLE ENERGY DEVELOPMENT INTO COUNTRY POLICIES AND PROGRAMMES CAN REVERSE THE LOSS OF ENVIRONMENTAL RESOURCES,

AND,

HOW SUSTAINABLE ENERGY DEVELOPMENT CAN IMPACT BIODIVERSITY LOSS, ACCESS TO SAFE DRINKING WATER, BASIC PROVISION SANITATION, AND THE LIVES OF SLUM DWELLERS.

ROLE OF ENERGY ACCESS IN ACHIEVING MDG 8 - DISCUSSION IX

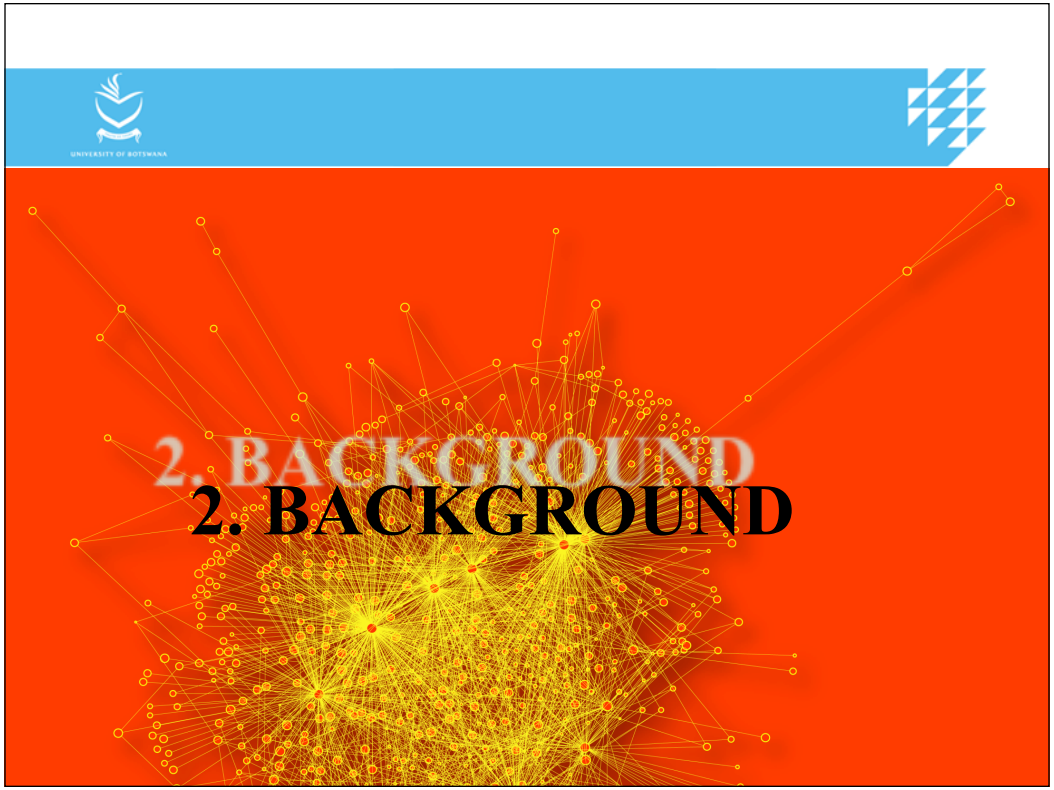
DISCUSS HOW ACCESS TO ENERGY SERVICES ENSURES THE DEVELOPMENT OF A GLOBAL PARTNERSHIP FOR DEVELOPMENT BASED ON THE FOLLOWING MDG 8 TARGETS:

- **8A DEVELOP FURTHER OPEN, RULE-BASED, PREDICTABLE, NON-DISCRIMINATORY TRADING AND FINANCIAL SYSTEM - INCL. COMMITMENT TO GOOD GOVERNANCE, DEVELOPMENT AND POVERTY REDUCTION,**
- **8B ADDRESS SPECIAL NEEDS OF THE LEAST DEVELOPED COUNTRIES - TARIFF & QUOTA FREE ACCESS TO COUNTRIES' EXPORTS, ENHANCEMENT OF DEBT RELIEF FOR THE HIGHLY INDEBTED POOR COUNTRIES (HIPC), CANCELLATION OF OFFICIAL BILATERAL DEBT, GENEROUS OFFICIAL DEVELOPMENT ASSISTANCE (ODA) FOR COUNTRIES COMMITTED TO POVERTY REDUCTION,**
- **8C ADDRESS SPECIAL NEEDS OF LANDLOCKED COUNTRIES AND SMALL ISLAND DEVELOPING COUNTRIES THROUGH THE PROGRAMME OF ACTION FOR THE SUSTAINABLE DEVELOPMENT OF SMALL ISLAND DEVELOPING STATES,**

ROLE OF ENERGY ACCESS IN ACHIEVING MDG 8 - DISCUSSION IX

DISCUSS HOW ACCESS TO ENERGY SERVICES ENSURES THE DEVELOPMENT OF A GLOBAL PARTNERSHIP FOR DEVELOPMENT BASED ON THE FOLLOWING MDG 8 TARGETS:

- **8D DEALING COMPREHENSIVELY WITH DEBT PROBLEMS OF DEVELOPING COUNTRIES THROUGH NATIONAL AND INTERNATIONAL MEASURES IN ORDER TO MAKE DEBT SUSTAINABLE IN THE LONG TERM,**
- **8E PROVIDE IN COOPERATION WITH PHARMACEUTICAL COMPANIES, ACCESS TO AFFORDABLE ESSENTIAL DRUGS IN DEVELOPING COUNTRIES,**
- **8F MAKE AVAILABLE IN COOPERATION WITH PRIVATE SECTOR, THE BENEFITS OF NEW TECHNOLOGIES, ESPECIALLY ICTs.**



2. BACKGROUND

2. BACKGROUND - ENERGY ISSUES AND RELEVANT FACTS IN AFRICA

1. THE MAJORITY IN AFRICA LIVE IN THE RURAL AREAS,

2. RURAL ELECTRIFICATION LEVELS ARE GENERALLY LOW THROUGHOUT THE CONTINENT,

3. AFRICAN COUNTRIES HAVE CHARACTERISTICALLY LOW HUMAN DEVELOPMENT INDICES (HDI),

4. THE ACHIEVEMENT OF THE MILLENNIUM DEVELOPMENT GOALS (MDGs) REMAINS A GREAT CHALLENGE,

5. ENERGY ACCESS, IT IS ACKNOWLEDGED, CAN UNLOCK MOST PROBLEMS ASSOCIATED WITH MDGs. IT IS THE MASTER KEY!,

6. AFRICA IS ENERGY SELF-INSUFFICIENT,

FOR EXAMPLE BOTSWANA IS RELIANT ON ELECTRICITY IMPORTS FROM NEIGHBORING SA

THE ELECTRICITY GENERATED AT THE MORUPULE POWER STATION CANNOT SUSTAIN CURRENT DEMAND.

RELIANCE ON MORE THAN 70% ELECTRICITY IMPORTS. THIS ENERGY INSECURITY COMPROMISES ECONOMIC STABILITY

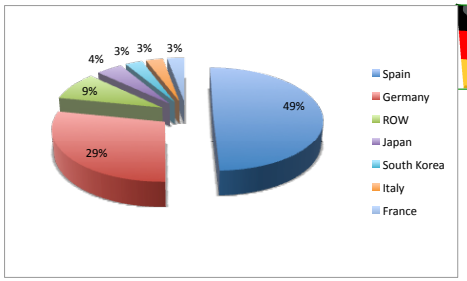
2. BACKGROUND - ENERGY ISSUES AND RELEVANT FACTS IN AFRICA

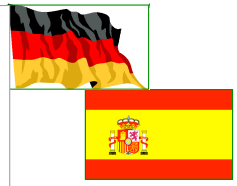
8. MOST AFRICAN COUNTRIES ARE SIGNATORIES TO INTERNATIONAL AGREEMENTS LIMITING GREEN HOUSE GAS EMISSIONS (GHG):
THIS ALONE COULD MOTIVATE FOR A DIVERSIFICATION AWAY FROM COAL TO RENEWABLE ENERGY BASED ELECTRICITY FOR INSTANCE, SOLAR PV.

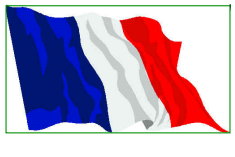
9. BEST CASE POLICY PRACTICES DO EXIST THAT COULD BE REPLICATED IN AFRICA. (E.G. GERMAN REFIT LAW)

10. THE FEASIBILITY AND POTENTIAL OF SOLAR PV TECHNOLOGY IS WELL DEMONSTRATED:
AT THE NATIONAL, REGIONAL, AND GLOBAL LEVELS,

GLOBAL, AND REGIONAL SOLAR TECHNOLOGY LESSONS







GLOBALLY, GERMANY & SPAIN: HAVE A COMBINED SHARE OF 78% OF THE TOTAL GLOBAL SOLAR PV TECHNOLOGY PENETRATION (Martin, 2008)

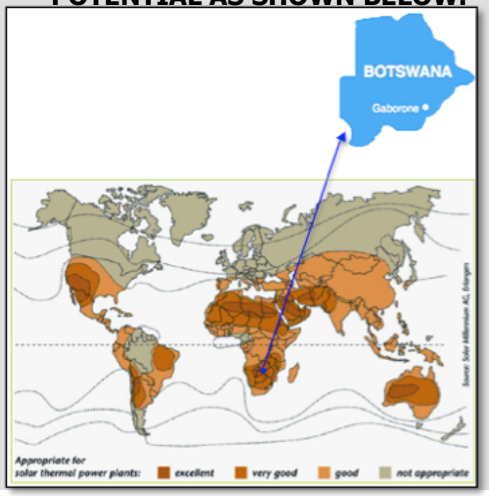
GERMANY: ~1368 AVERAGE SUNSHINE HRS/YEAR!

REGIONALLY, LA RE'UNION: 70,000 SWH IN 2006, +10000 UNITS/YEAR TO 2008. FOR A POPULATION OF 800000, RATIO IS 1 SWH: 11 PEOPLE

LA RE'UNION: A REGIONAL SWH MARKET LEADER

2. BACKGROUND - ENERGY ISSUES AND RELEVANT FACTS IN AFRICA

11. AFRICA IS ENDOWED WITH AN EXCELLENT SOLAR ENERGY POTENTIAL AS SHOWN BELOW.



FOR INSTANCE BOTSWANA'S SOLAR POTENTIAL IS DESCRIBED AS EXCELLENT

BOTSWANA HAS MORE THAN 3200 SUNSHINE HOURS ON AVERAGE IN A YEAR, WITH DNI LEVELS AROUND APPROXIMATELY 21MJ/m^2

BOTSWANA'S UNTAPPED COAL RESERVE IS ESTIMATED TO BE 212.8 BILLION TONS. ALSO SUBSTANTIAL COAL-BED METHANE RESERVES INDICATED

DESPITE THE EXISTENCE OF HUGE SOLAR AND COAL POTENTIALS, A CASE CAN BE MADE IN FAVOUR OF SOLAR TECHNOLOGY BUSINESS.

THE FUNDAMENTAL PROBLEM: WHY NOT PV?

DESPITE THE AFOREMENTIONED, THE ADOPTION OF SOLAR PV TECHNOLOGY IN AFRICA REMAINS LOW. IT SEEMS TO ME, THAT THE FUNDAMENTAL PROBLEM THAT NEEDS RESOLVING IS THE ABSENCE OF AN AFFIRMATIVE FRAMEWORK FOR SUSTAINING SOLAR PV CHOICE-DECISIONS OF POTENTIAL ADOPTERS.

FOR INSTANCE IN BOTSWANA AND DESPITE TANGIBLE RD&D CASES….

PV TECHNOLOGY PENETRATION IN RURAL AREAS REMAINS PRACTICALLY NON-EXISTENT

PV TECHNOLOGY ADOPTION IN URBAN AREAS IS EQUALLY VERY LOW

WHY? WHAT ARE THE UNDERLYING ISSUES?


3. PROPOSED
ABMS
METHODOLOGY

ANSWERING THE FUNDAMENTAL PROBLEM THROUGH AGENT BASED MODELING

IN ORDER TO DIFFUSE SOLAR POWER FOR AFRICA,

WE OUGHT APPRECIATE THAT: THE PROCESS LEADING TO SOLAR PV TECHNOLOGY ADOPTION INVOLVES VARIED FACTORS, ACTIONS, INTERACTIONS, AND GOAL-ORIENTED DECISION-MAKINGS OF MANY HETEROGENEOUS ACTORS.

THESE INTERACTING, HETEROGENEOUS BUT AUTONOMOUS, DECISION-ABLE STAKEHOLDERS ARE DESIGNATED FROM HEREON AS AGENTS.

TO CAPTURE THE COMPLEXITY OF THE INTERACTIONS DURING THE ADOPTION PROCESS WE APPLY A NEW MODELING PARADIGM:
AGENT-BASED MODELING AND SIMULATION (ABMS)
TO PV TECHNOLOGY DIFFUSION

DIFFUSION DEFINED IN NETWORK SCIENTIFIC TERMS

DIFFUSION

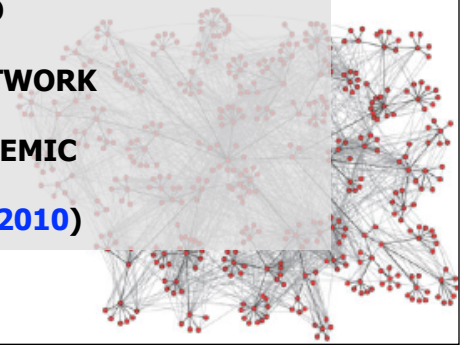
IS A BEHAVIOR THAT CASCADES FROM

NODE TO

NODE IN A NETWORK

LIKE AN EPIDEMIC

(KLEINBERG, 2010)



PV DIFFUSION NETWORK

SHALL COMPRISE OF A WEB OF NODES REPRESENTING INDIVIDUAL AGENTS WHERE THE LINKS BETWEEN THEM REPRESENT CHANNELS FOR THEIR INTERACTIONS.

THE COMMUNICATED INFORMATION SHALL BE THE DESIRED ADVOCACY FOR PV AWARENESS AND EVENTUAL ADOPTION

MICROLEVEL DECISIONS → MACRO-LEVEL DIFFUSION

THE OBJECTIVE IS THEREFORE:

TO WEAVE FROM BOTTOM-UP,
A DYNAMICALLY-EVOLVING NETWORK OF PV ADOPTERS,
BASED ON EMPIRICAL EVIDENCE OF
WHAT AGENTS DEEM TO BE THE MAIN FACTORS MOTIVATING THEIR
SOLAR PV TECHNOLOGY CHOICE-DECISIONS.

ALTERNATIVELY, TO GROW
FROM THE PERSPECTIVE OF THE ENERGY END-USERS,
AFFIRMATIVE POLICIES THAT ARE
CAPABLE OF SUSTAINING PV TECHNOLOGY CHOICE-DECISIONS.

FROM END-USER BEHAVIORS → TO DIFFUSION-GUIDING POLICY

WHAT INSPIRES THIS METHODOLOGY?

OBSERVATIONS EMERGENT SELF-ORGANIZATION OF INTERACTING BIOLOGICAL AGENTS. THE "AGENTS" ARE CAPABLE OF PRODUCING SELF-ORGANIZATION WITHOUT A DIRECTOR

HERE SOME EXAMPLES:

FROM SIMPLE RULES TO → EMERGENT SELF-ORGANIZATION

HERDING BEHAVIOR

NO LEADER! HERDING EMERGES FROM SELF-ORGANIZATION

MIGRATING BIRD FLOCKS

A MACRO-LEVEL FLOCKING DYNAMIC EMERGES FROM SIMPLE, COORDINATED INDIVIDUAL, MICRO-LEVEL RULES

BEE SWARMS

SWARM INTELLIGENCE !

A COLLECTIVE SYSTEM-LEVEL INTELLIGENCE EMERGES FROM MICRO-LEVEL RULES OF THE CONSTITUENT MEMBERS.

AND THERE ARE ALSO SCHOOLS OF FISH, ANT ARMIES ....

AGENTS DO NOT SOLVE ANY COMPLICATED EQUATIONS

NOR HAVE FULL INFORMATION ON ALL AGENTS. THEY DEPEND ON LOCAL RULES AND INFORMATION.

PRACTICAL HUMAN DECISION-MAKING IS SIMILAR IS A SATISFICING SOLUTION

AS WE UNDERTAKE REALISTIC DECISION-MAKINGS,

WE OFTEN DO NOT HAVE ALL THE INFORMATION (AWARENESS) TO BACK OUR DECISIONS. WE DO NOT SOLVE MAJOR EQUATIONS, INTEGRATE VARIABLES ETC TO ARRIVE AT AN OPTIMAL SOLUTION. IN FACT WE NEITHER HAVE THE ABILITY TO INCLUDE ALL RELEVANT FACTORS, THE COMPUTATIONAL ABILITY TO PROCESS THEM, NOR THE TIME TO WAIT LONG-ENOUGH FOR THE OPTIMAL SOLUTION.

INSTEAD WE SETTLE FOR A SATISFACTORY AND SUFFICIENT SOLUTION. SUCH A SOLUTION IS A SATISFICING SOLUTION.

SATISFICING IS FOUNDED ON THE BOUNDED RATIONALITY MODEL OF HUMAN DECISION-MAKING.

SATISFICING IS A HALLMARK OF AGENT-BASED MODELING

IMPLEMENTING AN ABMS FRAMEWORK FOR SOLAR PV DIFFUSION IN THE BOTSWANA HOUSEHOLDS

WHO ARE THE AGENTS ?

No	AGENT	INIT	FUNCTION / EXPLANATION
1	Botswana Power Corporation	BPC	Botswana's only power utility company
2	Energy Affairs Department	EAD	Government Department overseing energy markets, policy, regulation, guidelines, pricing etc
3	Research Fraternity	RES	General information communication relative to energy research, education, and advocacy
4	Environmental Affairs Department	DEA	Government Department overseing environmental matters.
5	The Media	MED	Papers, Telephones, Radio, Television, and the New Social Media eg. Mobile phones
6	Ministry of Finance and Economic Development	MFED	Main funder of Government Projects, initiatives, and development projects.
7	Botswana Bureau of Standards	BOBS	Oversees adherence and compliance on locally- and international standards.
8	Public Procurement and Assests Disposal Board	PPADB	Responsible for Government purchases. Can influence import tarifs and custom duties
9	Somarelang Tokologo	SOMT	Botswana Private Environmental "Watchdog", an NGO
10	Southern African Development Corporation	SADC	The Southern Africa Development Corporation. May sway regional energy policy
11	The Botswana Household	HHs	The Botswana Household is the target energy end-user agent in the Agent-based Model.

DISCUSSION - X

GIVEN A RURAL SETTING IN YOUR OWN COUNTRY,

WHO IN YOUR OPINION,

WOULD YOU LIST AS AGENTS,

THAT MAY LIKELY INFLUENCE DECISION-CHOICES

FOR SOLAR PV TECHNOLOGY ADOPTION?

WHICH QUESTIONS SHOULD AN EMPIRICAL STUDY THEN SEEK TO ANSWER?

Premise	Awareness significantly influences PV diffusion (PVTD) in the Botswana Households
Rationale:	Do agents know the potential personal or public good of PVTD?
	What information relevant for PV Technology awareness do agents possess?

Premise	PV Technology awareness is a culture-weighted variable
Rationale:	Can agents responsible for communicating PVT knowledge be identified?
	Who are the dominant agents influencing PVT choices in households?

Premise	Satisficing is a significant motivation for PVT adoption
Rationale:	Can the factors and goals motivating agents' propensity to adopt be established?
	How do agents rank the motivating factors and goals?

WHICH QUESTIONS SHOULD AN EMPIRICAL STUDY THEN SEEK TO ANSWER?

Premise	A scale-free PVT adopter network is significant in accelerating PVT diffusion
Rationale:	Can agent-identified rules give rise to an emergent PVT adoption pattern?
	What must be fullfilled as a pre-condition for PVT adoption?

Premise	Effective ommunication significantly influences PVTD in Households
Qualification:	Can the channels of PVT awareness communication be established?
	How and when is inter-agent PVT information propagated?

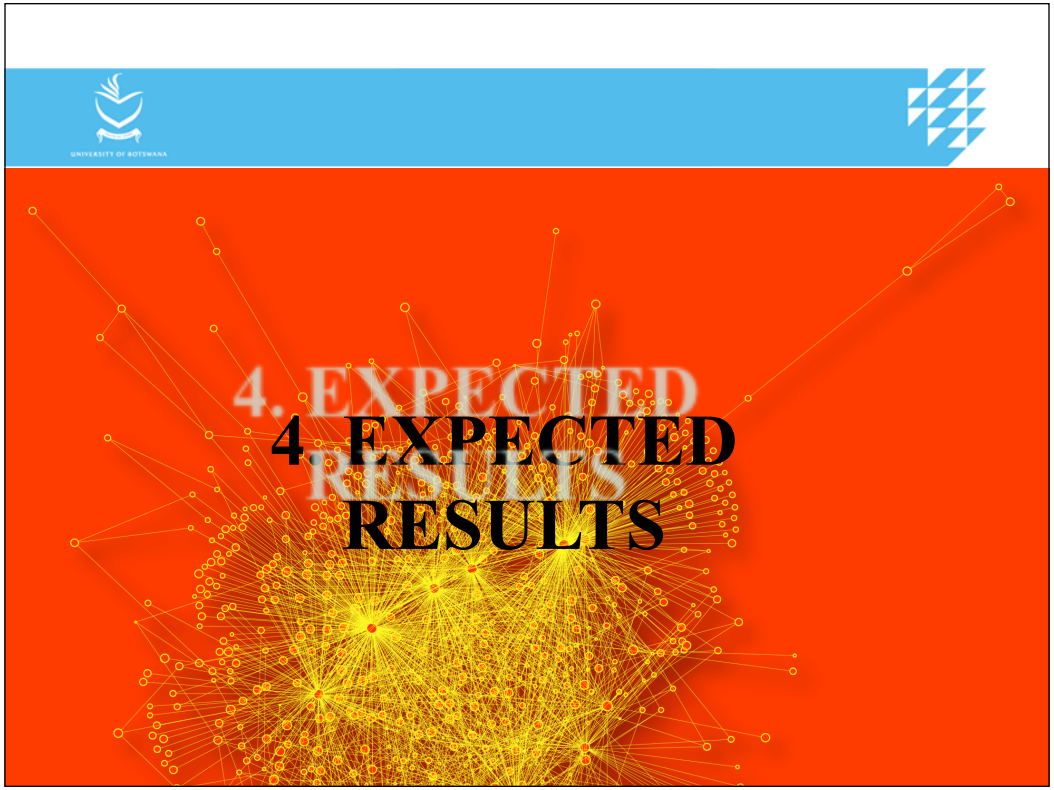
DISCUSSION - XI

GIVEN THE UNIQUE SETTING IN YOUR OWN COUNTRY,

WHICH SPECIFIC QUESTIONS WOULD YOU ASK WITH REGARD

TO THE PREMISES AND THE GENERAL QUESTIONS

CITED ABOVE?

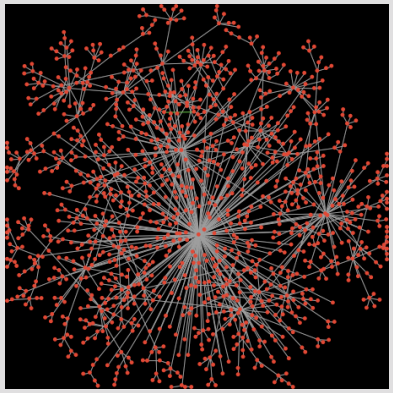


4. EXPECTED RESULTS

3. EXPECTED OUTCOME: INFORMING RENEWABLE ENERGY POLICY

- SCALE-FREE NETWORK, THUS ASSERTING ROBUSTNESS,
- IDENTIFIABLE HUBS - DRIVERS SUSTAINING THE DIFFUSION PROCESS
- DISCERNIBLE FACTORS, THUS PROVIDING AFFIRMATIVE POLICY CUES,
- IDENTIFICATION OF POSSIBLE INCENTIVES WORTH TARGETING,
- RESULTS USEFUL TO ENERGY POLICY PLANNERS,
- ACCELERATION OF THE PVT DIFFUSION HOUSEHOLDS,
- RESULTS THAT CAN BE CASCADED TO INCLUDE:
  - SECTORS OTHER THAN THE HOUSEHOLD SECTOR,
  - OTHER NON-SOLAR TECHNOLOGY DIFFUSION,
  - OTHER COUNTRIES IN THE REGION, BESIDES BOTSWANA.

EXPECTED OUTCOME: A SCALE-FREE NETWORK WITH IDENTIFIABLE HUBS

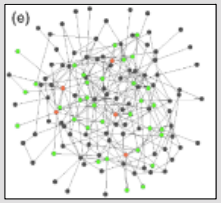


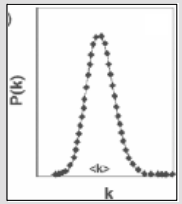
EMPIRICAL FIELD DATA SHALL GENERATE AND ACCOUNT FOR THE SCALE-FREE NETWORK

HUBS ARE THE WELL-CONNECTED AMONG ALL NODE AGENTS

DISTINCTION: SCALE-FREE VIS-À-VIS RANDOM NETWORKS

RANDOM (ERDOS & RENYI, 1950)

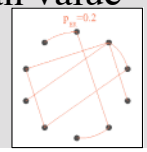




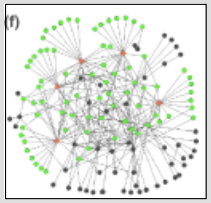
BINOMIAL(~POISSON) DEGREE PROBABILITY DISTRIBUTION

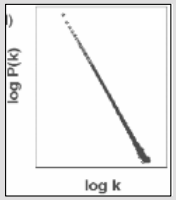
$$P(k) = \frac{(np)^k e^{-pn}}{k!} = \frac{\langle k \rangle^k e^{-\langle k \rangle}}{k!}$$

np = mean value



SCALE-FREE (BARABASI & ALBERT, 2000)

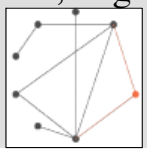


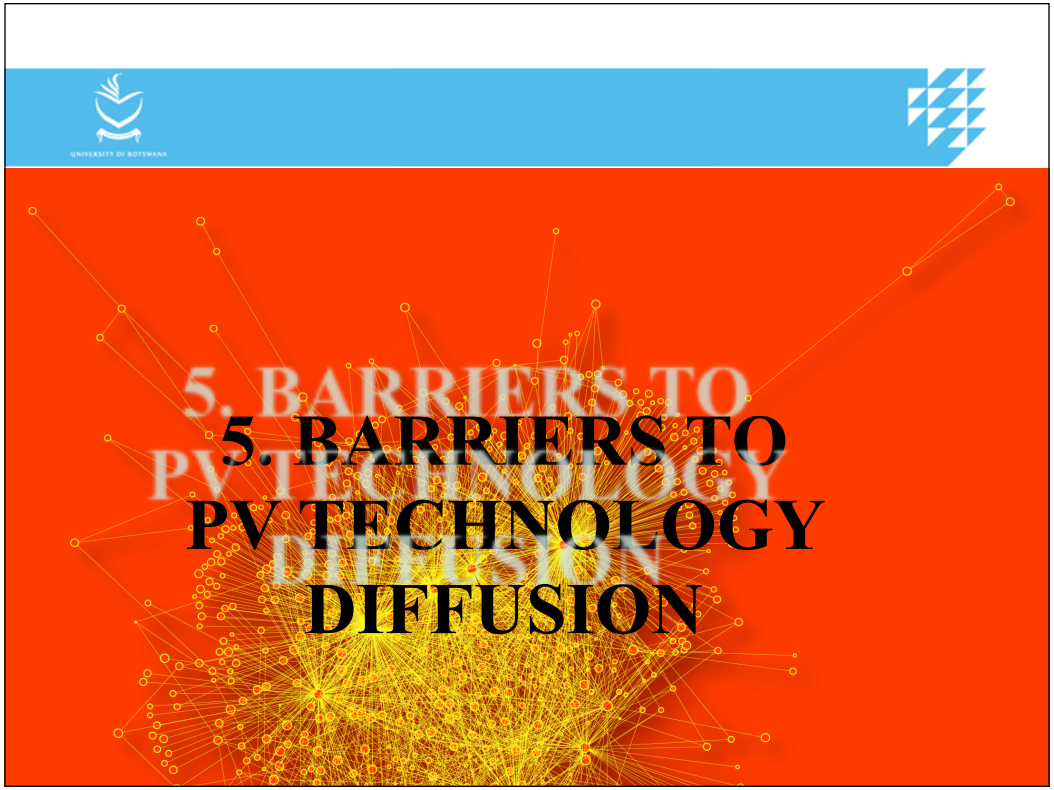


POWER LAW DEGREE PROBABILITY DISTRIBUTION

$$P(k) = \frac{2m_o^{\,2}t}{(n_o + t)} \frac{1}{k^3} \propto k^{-3}$$

n_0, m_0 nodes, edges at 0 and t

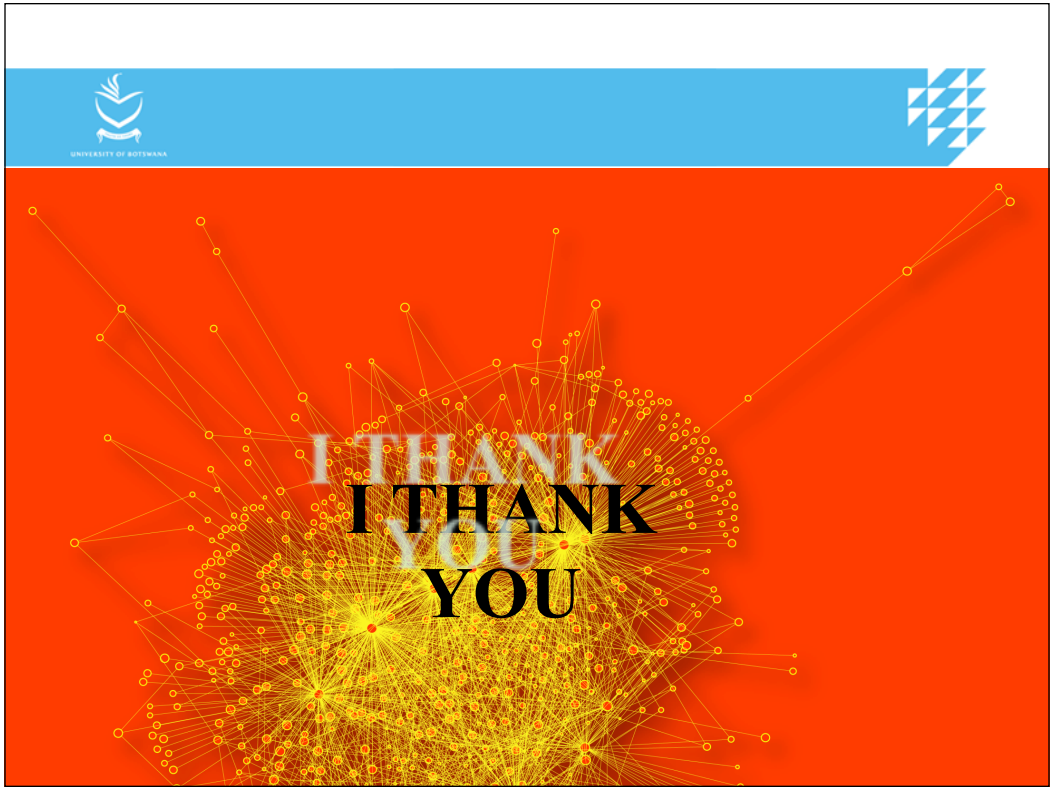



5. BARRIERS TO
PV TECHNOLOGY
DIFFUSION

BARRIERS TO PV TECHNOLOGY DIFFUSION
DISCUSSION XII

PROVIDE CUES AND PROMPTS FOR DISCUSSING THE BARRIERS TO PVT AND THE POSSIBLE LESSONS FOR PVT DIFFUSION IN AFRICA

REFERENCES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