Multi criteria selection of DRE sites using Simple Additive Weighting (SAW)

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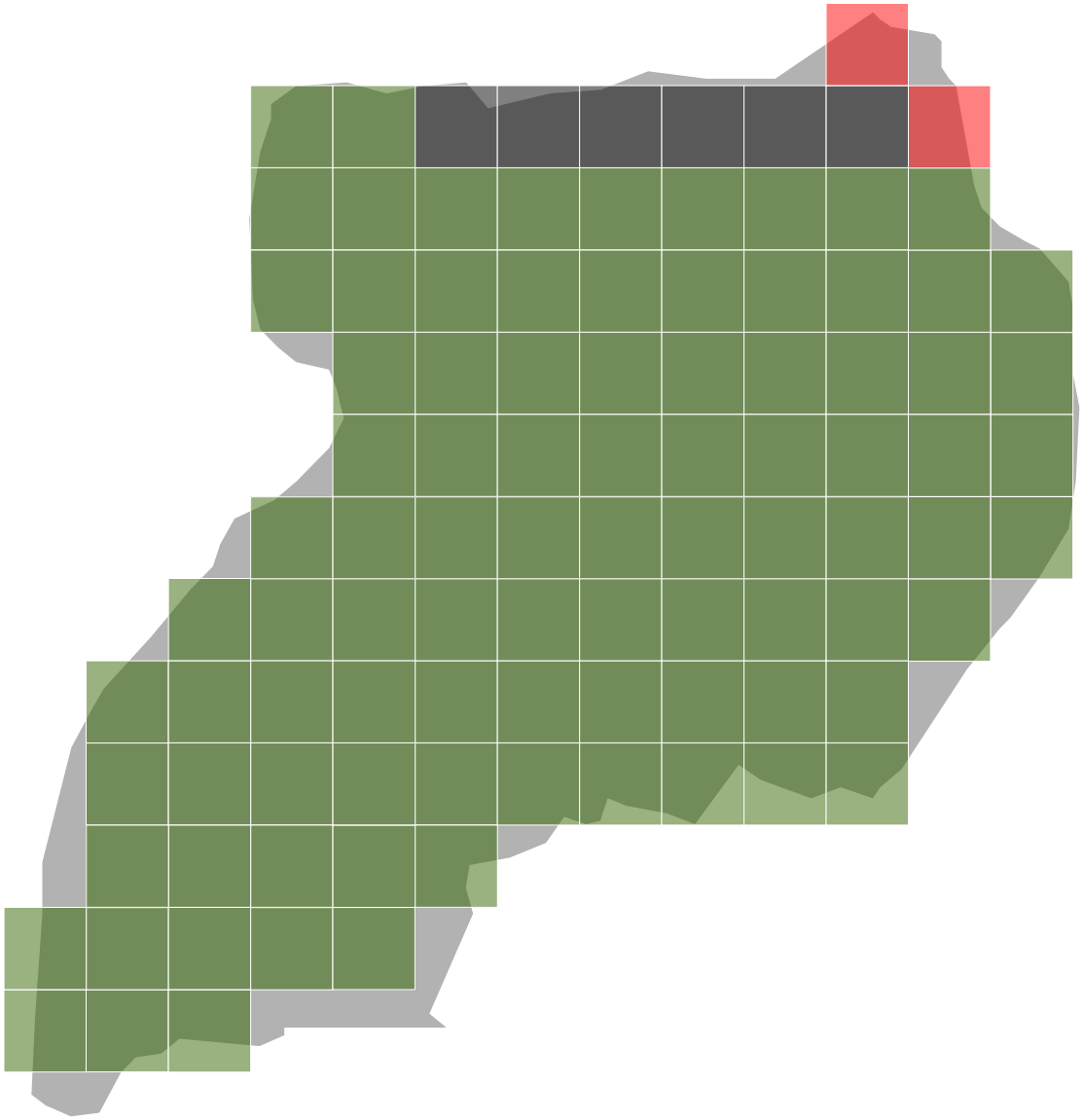
Introduction-Uganda energy situation



biomass

92%

petroleum

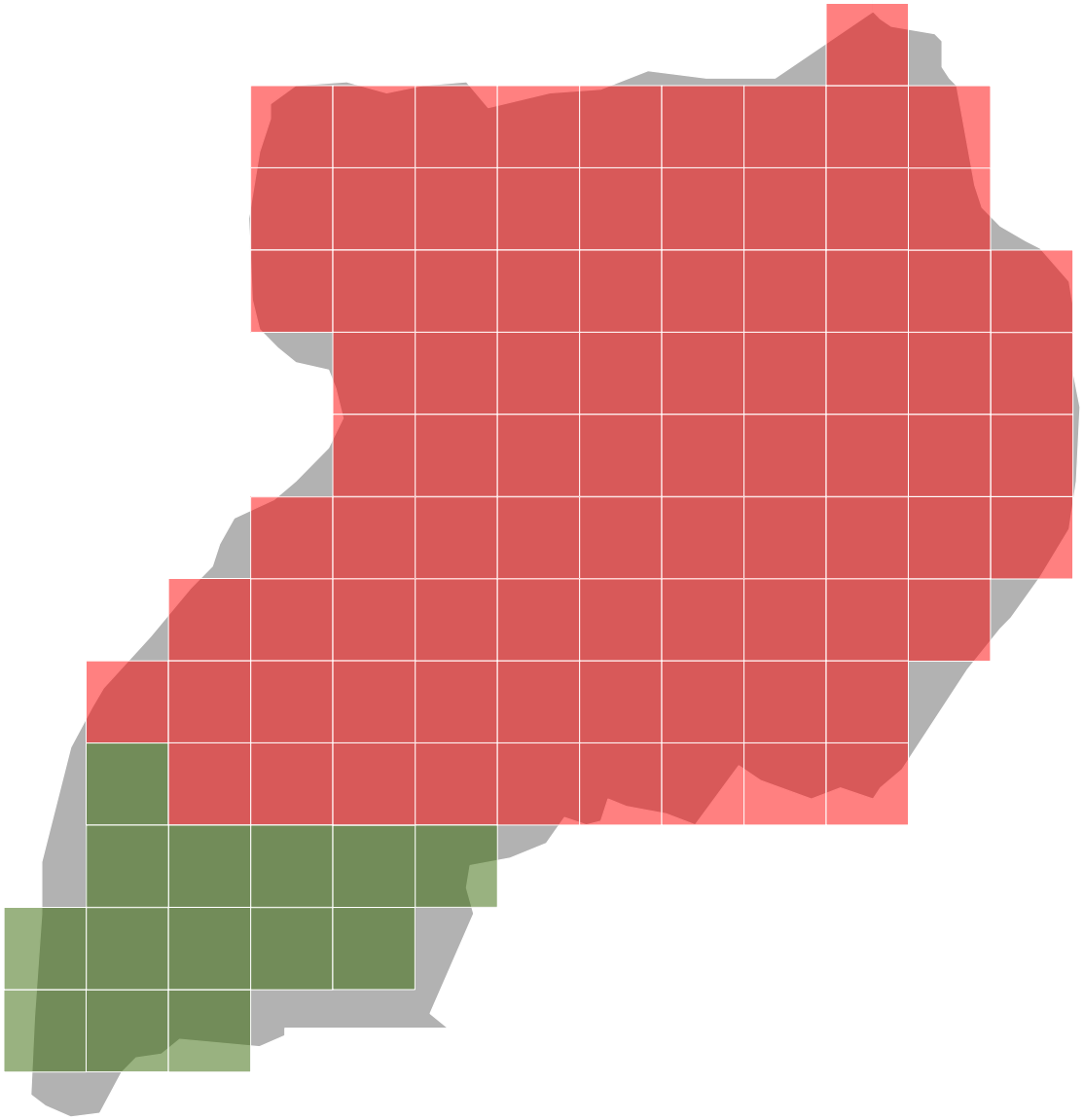
6%

electricity

2%

Okure, 2009

Uganda - electrification rate (national grid)



access

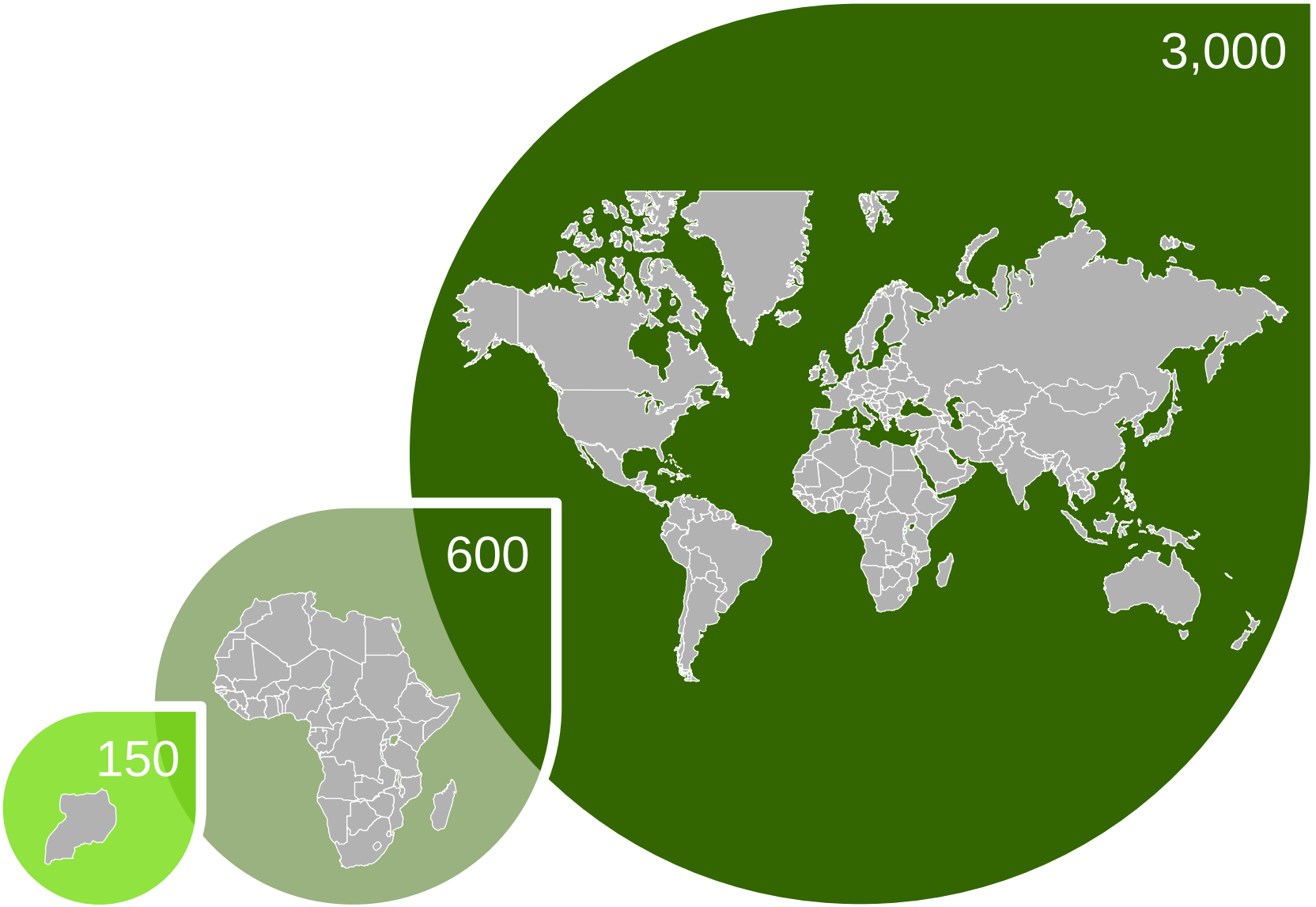
14%

no access

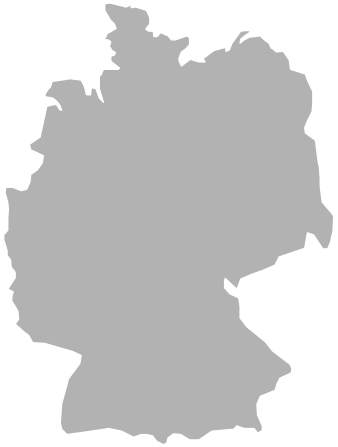
86%

REA, 2013

Uganda - per capita use (kWh/yr)



Installed capacity

UG	A	D	NL
			
36 mio	8 mio	81 mio	17 mio
241,000 km^2	84,000 km^2	357,000 km^2	41,500 km^2
850 MW	21,000 MW	178,000 MW	30,000 MW
	25 x	209x	35x

CIA, The World Factbook

Background/Justification

- Preference and priority is on extension of the existing electricity grid. However, it is becoming clear that grid extension is not possible everywhere

- Small-scale, independent grid systems are promoted by the government of Uganda as the next step in rural electrification through the Rural Electrification Strategy and Plan (RESP) for the period 2013 to 2022

Background/Justification

Where these micro-grid systems are not feasible, stand-alone systems such as solar PV home systems or even the smallest pico solutions are used

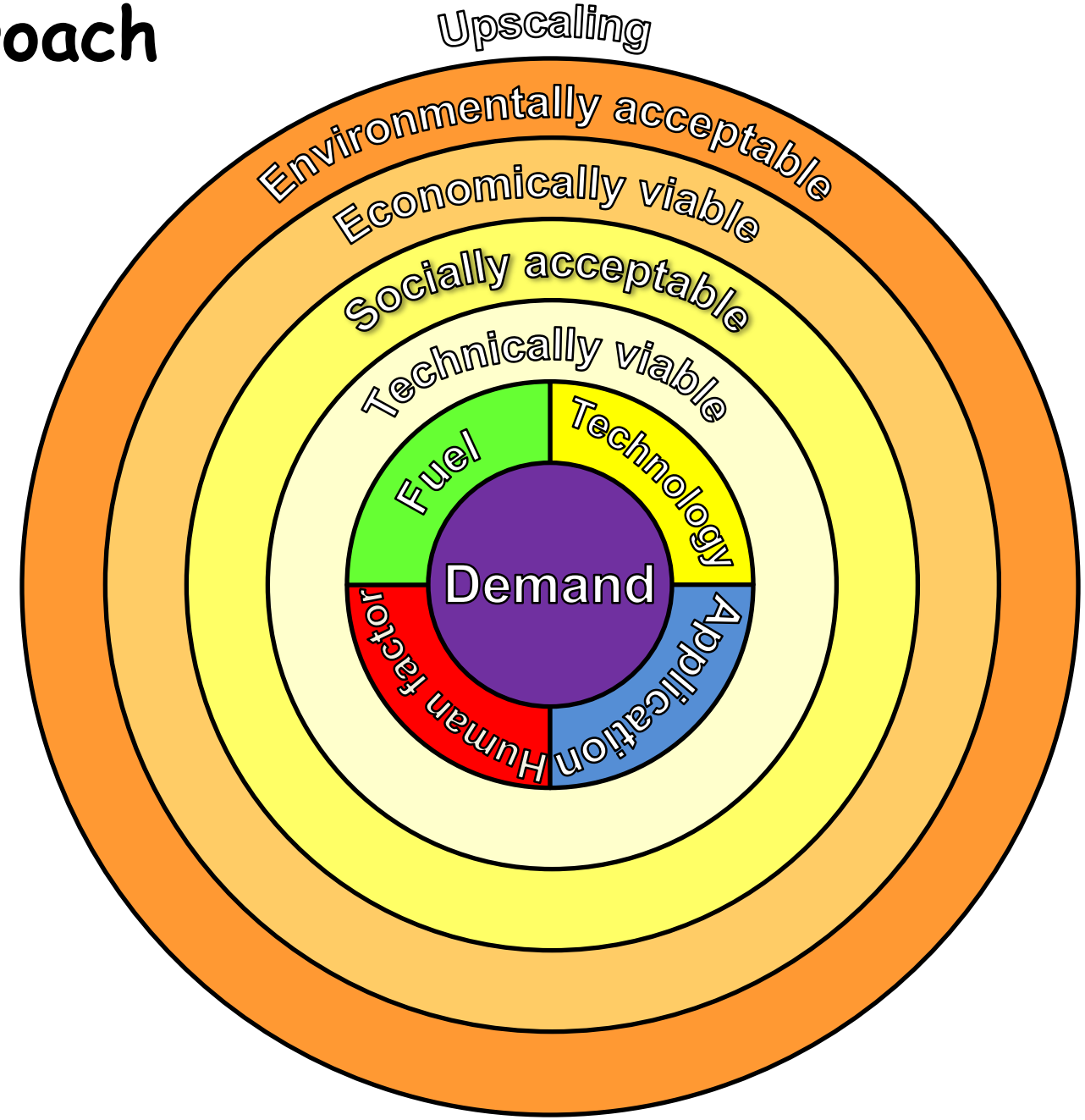
Problem Statement

One of the biggest questions of renewable energy projects is :where should they be placed or sited?. There has to be scientific means to choose a location based on relevant success factors.

Research Objectives

1. Selection of a set of decision makers
2. Scoping of possible sites using referenced data
3. Design of relevant attributes
4. Determination of performance ratings of attributes for each site
5. Assignment of importance weights for attributes
6. Ranking selected sites using SAW

Approach


Upscaling
Environmentally acceptable
Economically viable
Socially acceptable
Technically viable
Fuel
Technology
Demand
Human factor
Application

Method

The Simple Additive Weighting technique

an evaluation score can be calculated for each alternative by multiplying the scaled value given to the alternative of that attribute with the weights of relative importance directly assigned by decision makers or experts, followed by summing of the products for all attributes.

Method

The final score of each alternative is obtained as follows;

1) A set of decision makers or experts are selected depending on the technologies considered,
2) A set of possible alternatives,

$$A = (A_1, A_2, \ldots, A_m)$$

3) A set of attributes to measure the performance of the alternatives,

$$C = (C_1, C_2, \ldots, C_j)$$

Method

4) The performance rating of alternative, A_i , with respect to attribute, C_j , provided by the experts is denoted by, r_{ij}

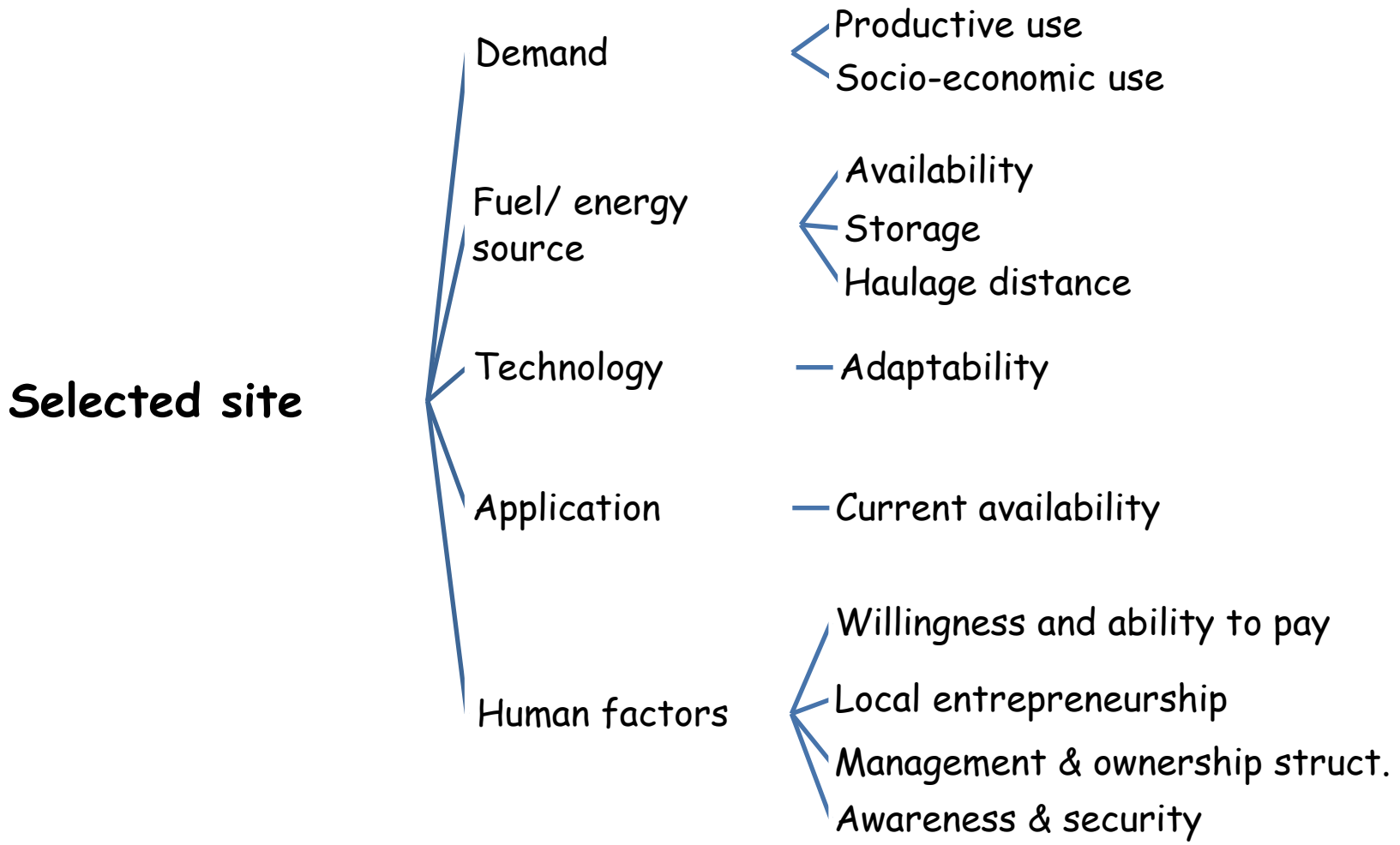
$$j = 1, 2, \ldots, n \quad ; \quad i = 1, \ldots, k$$

5) The importance weight of attributes, C_j , provided by the experts is denoted by, W_j ,

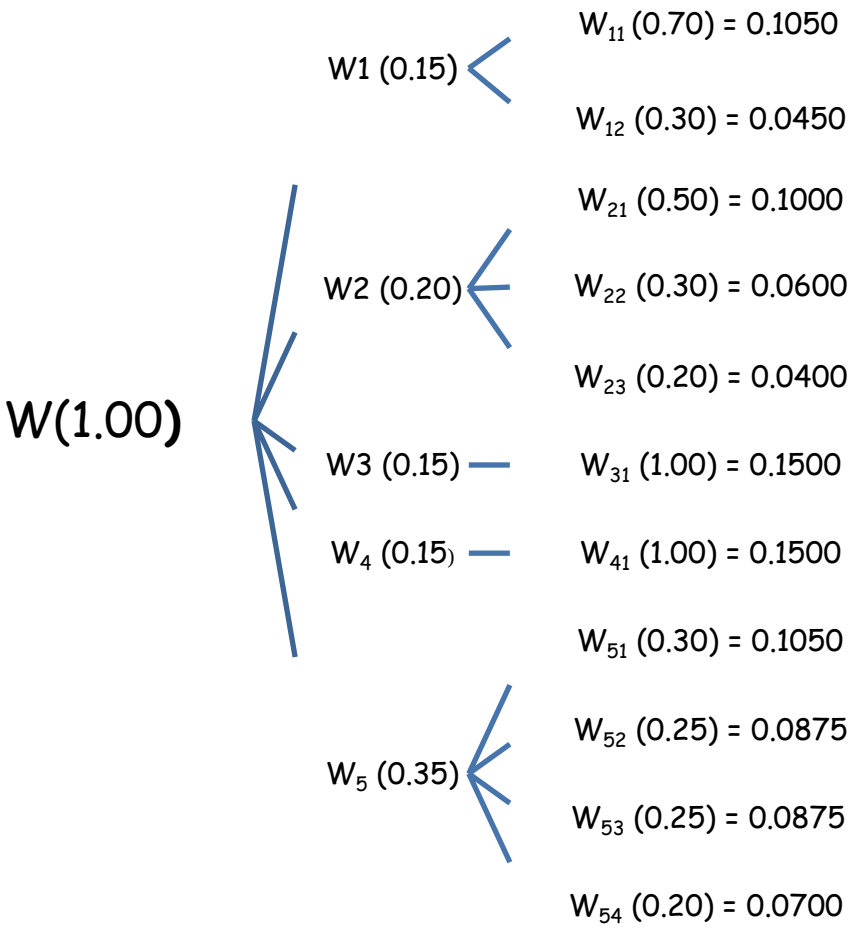
6) The score for each alternative , V_i , is obtained by summing the product of the importance weight of each attribute, W_j , and the performance rating, r_{ij} , of each alternative site as stated in the equation below;

$$V_i = \sum_{j=1}^{n} w_j r_{ij}$$

Results- Attributes



Results- Importance weights of attributes



Results- Evaluation scores

Site location	Alternative	Score
Muduma-Mpigi	G1	0.53
Opit-Gulu	G2	0.85
Sekanyonyi - Mityana	G3	0.68
Bussunju - Wakiso	G4	0.50
Doctina - Jinja	G5	0.52

Site location	Alternative	Score
Haven-Jinja	H1	0.78
RMS-Kasese	H2	0.89
Arlington - Mbale	H3	0.60
Wild waters - Jinja	H4	0.82
KSB site 3 - Jinja	H5	0.75

Site location	Alternative	Score
Kabanga - Mukono	S1	0.65
Mayuge-Iganga DSS1	S2	0.28
Mayuge-Iganga DSS1	S3	0.37
Mayuge-Iganga DSS1	S4	0.32
Nakasengere - Kiboga	S5	0.76

Site location	Alternative	Score
Flora poultry-Mukono	B1	0.65
Softpower-Jinja	B2	0.73
Jesa - Mityana	B3	0.91
Meat packers - Kampala	B4	0.70
Arlington - Mbale	B5	0.76

Results- Developed sites

Site	Alternative	Technology	kW	Funds
Opit	G2	Gasification	10	MSI
Sekanyonyi	G3	Gasification	10	MSI
Muduma	G1	Gasification	32	Norgesvel
Kabanga	S1	Solar PV kiosk	01	MSI
Nakasengere	S5	Solar PV grid	01	MSI
RMS-Kasese	H2	Pico hydro	05	WB

Productive Use Unit-Opit Gulu

Future work

- Non linear tool in a fuzzy environment
- An application with ex-post analysis and time dimension
- Sensitivity analysis