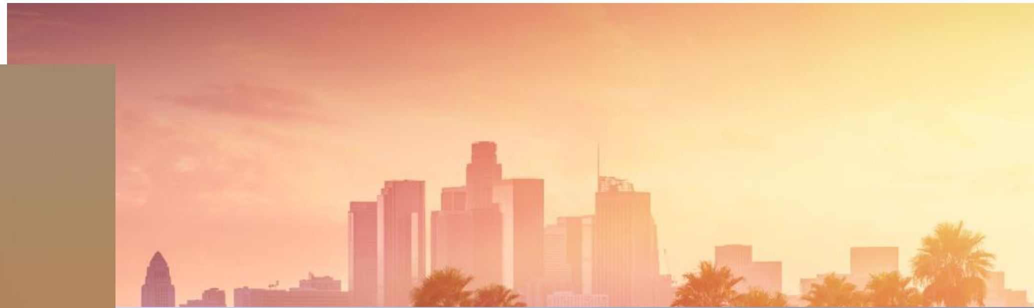
Opportunities to improve community wellbeing through alternative air quality improvements

SAIMM ESG in the Minerals Industry Challenges and Opportunities – October 2024



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- Background
- Legal setting
- Case Study
- Social mapping
- Available options
- Implementation
- Lessons learnt

Background

Poor Air Quality

- Highveld Region – Vaal Triangle and Mpumalanga Highveld Priority Areas
- Low-income areas worst affected
- Seasonal Variation
- Health Impacts

Challenges

- Historical legacy of dirty fuels in low-income communities
- Poor quality of houses
- Aging industries unable to comply with new air quality legislation
- Balancing ongoing operations and sustainability

Some of the issues but not all

Legal setting

- NEM – Air Quality Act 39, 2004
  – Section 21 Minimum Emission Standards + amendments
  – GHG Reporting Regulations

- Carbon Tax Act 15, 2019
  – Section 19c Offset regulation + amendments

- Climate Change Act 22, 2024
  – Commencement date to be proclaimed

Case Study

MES Postponements

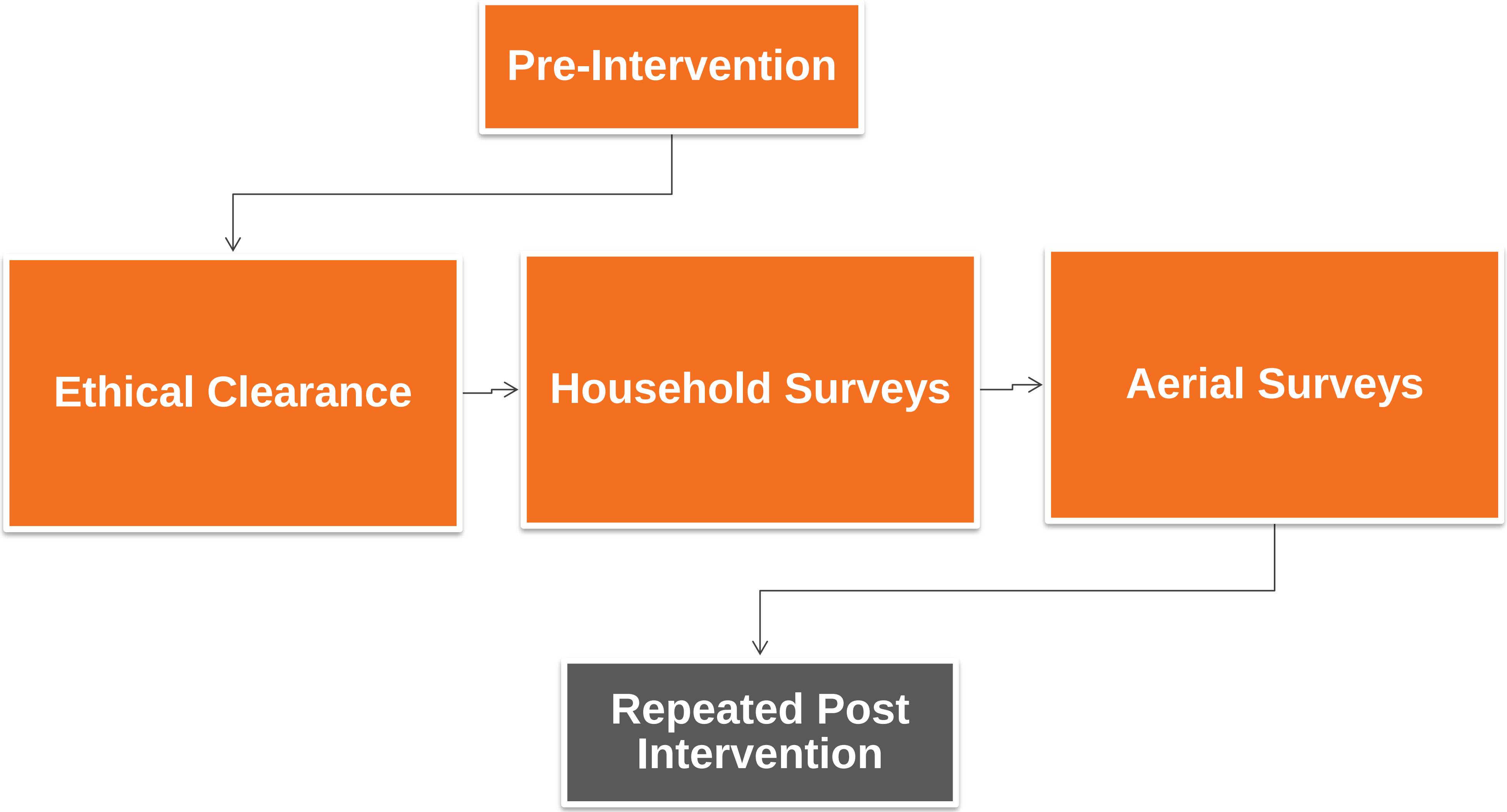
- Companies were granted postponement from compliance with the MES timeframes for specific plants
- Postponement for specific emissions per activity

Conditions

- Plan on how they will meet compliance by 2020 / 2025
- Submit a mitigation plan
- Explore offsets to compensate for relaxation of compliance with MES
- Balancing ongoing operations and sustainability

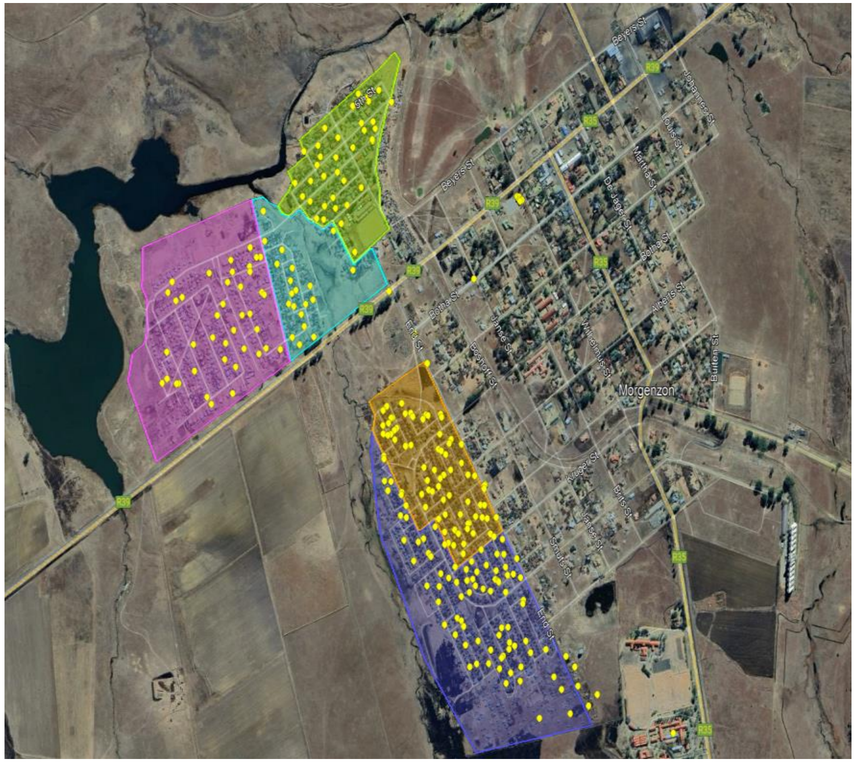
Due to confidentiality reasons no refences to clients and facilities

Social Mapping



Household Survey Results

Type of housing	Extension	Number of households	%
Formal	Ext 1	25	8.5
	Ext 2	91	31.1
	Ext 3	71	24.2
	Ext 4	53	18.1
	Old Location	40	13.7
Sub-total		**280**	**95.6**
Informal	Ext 3	2	0.7
	Ext 4	**2**	0.7
	Shack dwellers	8	2.7
Sub-total		**12**	**4.1**
Blank	Ext 3	1	0.3
Total		293	**100**

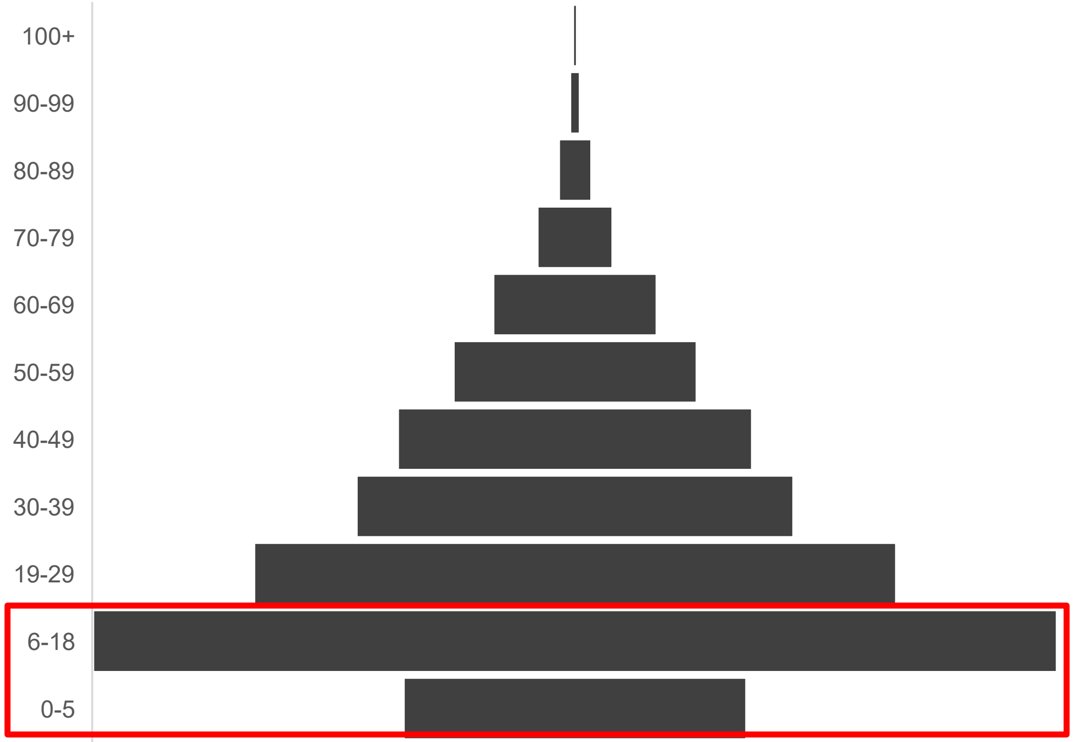


Type of housing	n	Mean
Formal	280	4.0
Informal	12	3.7
Blank	1	3

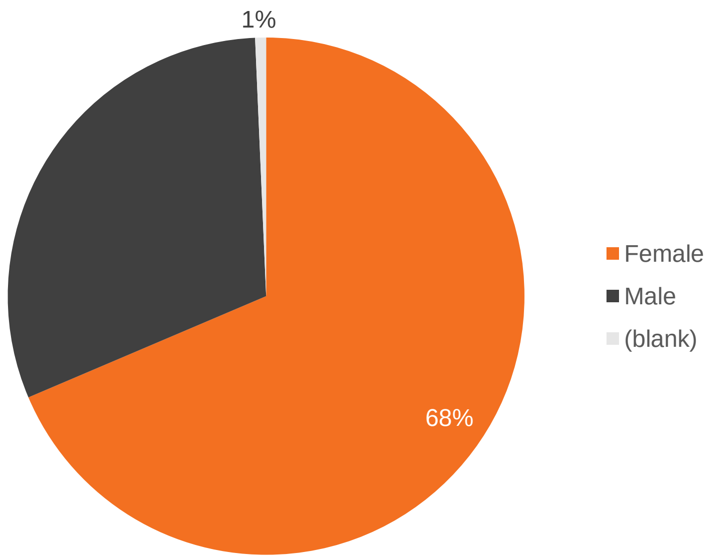
Demographics Age & Gender

Age range	0-5	6-18	19-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100 +	Total
No. of household members	121	339	226	154	125	86	58	27	12	4	2	1154
% of household members	10.5	29.4	19.6	13.3	10.8	7.5	5.0	2.3	1.0	0.3	0.2	100

Age ranges of household members

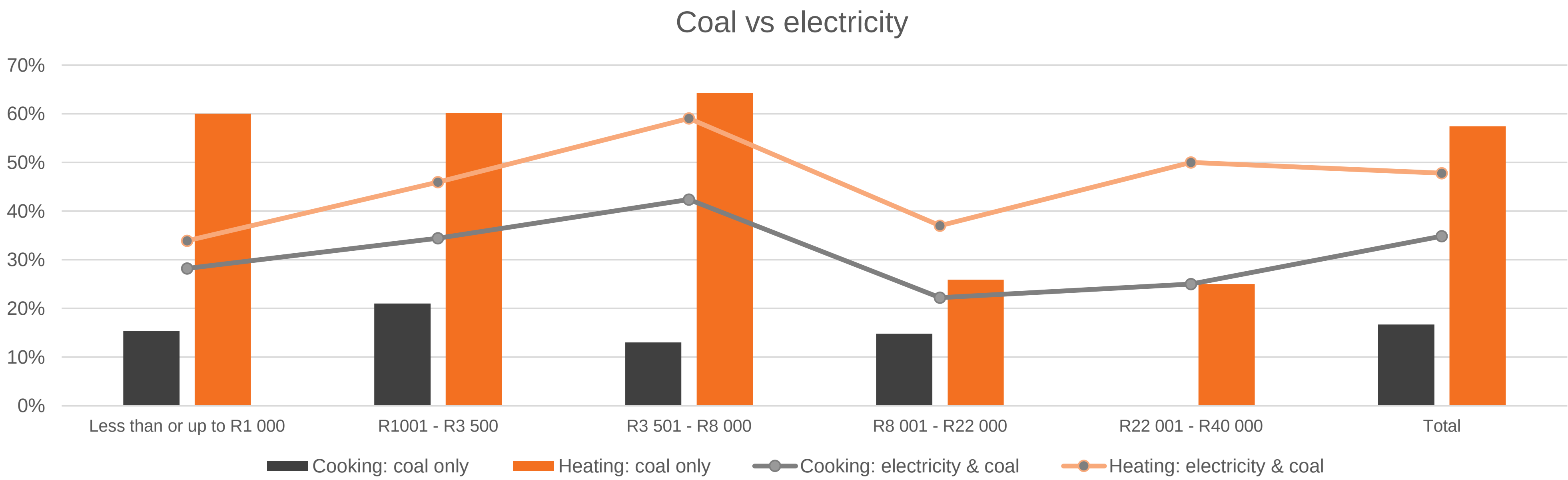


Genders of household heads



Energy Usage

- **Coal** used mainly as **heat** source
- Households **not dependent** on coal for **cooking** – mostly stacked with electricity
- Wealthier households don't use coal **exclusively** for cooking
- Most households have electricity
- Electricity used mostly for cooking (alone or in combination with other sources)
- More **stacking** in **lower- to mid-income** households
- More **stacking** for **cooking** than for heating



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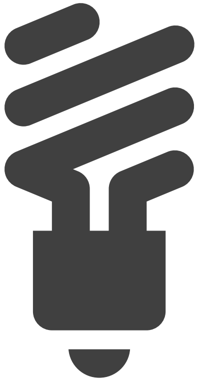
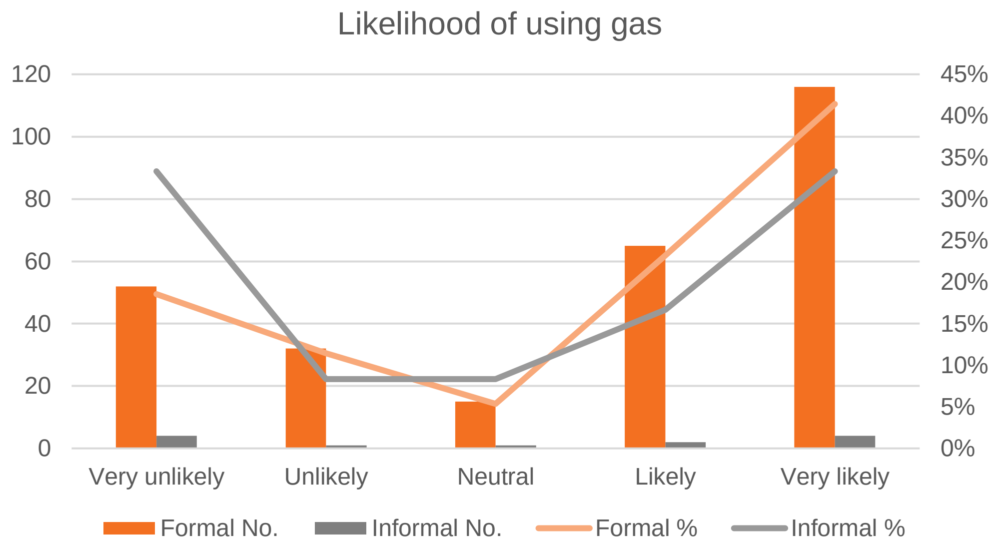
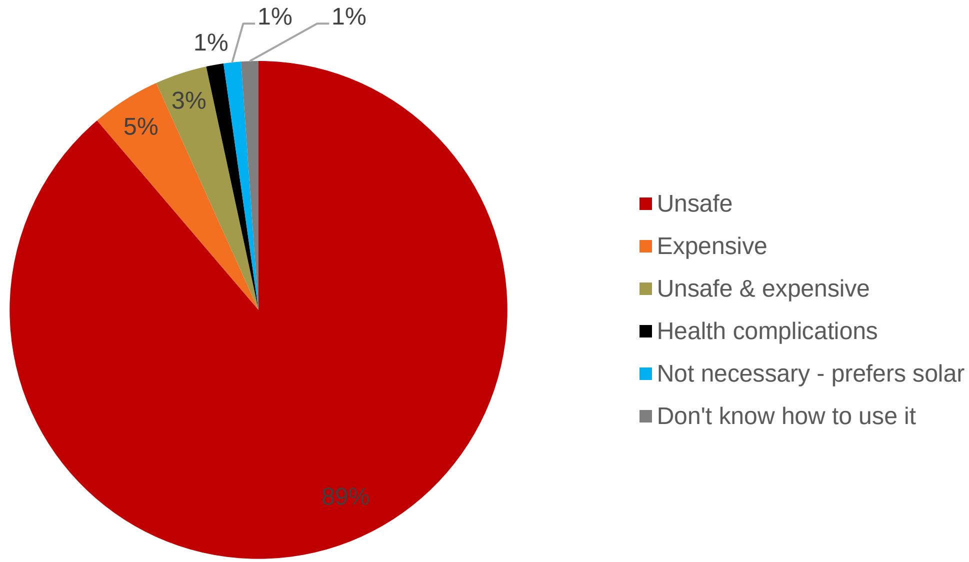
Interventions



- 97% of households surveyed use or would consider using energy-saving bulbs
- 3% do not / would not
- Due to:
  - Bulbs not fitting light fixtures / lamps
  - Bulbs not being bright enough
  - Not knowing what it is





Research Areas – Intervention opportunities

Alternative energy

- Solar microgrids
- Solar home systems
- Solar geysers
- Small scale wind turbines
- Agri voltaic farming

Alternative energy to communities

PROS	CONS
Solar microgrids - independent, decentralized electricity networks that can function separately from a national grid. For local consumption	
• Supply a larger number of users and well suited to small remote communities • Potential for upskilling and job creation • Can supply to schools and small businesses • Potential to generate income and reduce poverty in off grid communities • Has the potential to power entire households i.e., lighting, geysers, heating etc. • Can be incorporated into RDP housing designs and easy to maintain	• High upfront infrastructure and installation costs • Return on investment and rate of return is slow for project owner • Requires a lot of community engagement to determine what the needs are
Solar home systems - Provide power for low power DC appliances such as lights, radios, and small TVs for about three to five hours a day.	
• Potential improvement to quality-of-life i.e.. extends household lighting periods, children have longer study hours, decreases risk of accidents related to paraffin/ kerosene lighting • Satisfies basic energy needs, even if areas are off-grid • Can be incorporated into RDP housing designs	• High capital and installation costs • No direct opportunities for job creation or income generation
Solar geysers - used for heating water for cooking, bathing etc. Could possibly be used for water purification (above certain temperatures)	
• Low maintenance • Can be co-opted as water purification (has been tested in a rural village in Iran)	• High investment costs in relation to the benefit that they provide • Don't work well in winter • Often not preferred since cheaper options are available to heat water
Wind: **small scale wind turbines -** small scale windfarm with smaller turbines to generate power for rural communities	
• Potential for upskilling through training people in a technician training programme • Clean energy that can potentially power schools and small businesses depending on the scale of the wind farm • Potential for a hybrid option with other clean energy sources	• More costly to produce electricity, especially in places where there is no wind • A lot of consideration and research has to go into the design at the preset in • High maintenance requirements that can be very expensive • Power generation can be extremely variable (highly reliant on weather) • May have lengthy repair times which could render the option unsustainable
Solar Agrivoltaic farming - Solar panels are raised aboveground so that crops can be grown underneath them (dual land use)	
• Potential for upskilling and job creation in two sectors • Allows for dual land use with different social benefits in the form of clean energy generation, food resources in the form of crops or livestock. • Less water may be needed for irrigation depending on the crop that is planted which is beneficial in a water scarce country • The water that does evaporate assists with cooling the panels extending their life • Can support small livestock farms whereby animals can graze beneath the panel • Offers solutions to water saving, clean energy production, and food production in one project	• Will require a comprehensive understanding of technical aspects of implementation • Will require research on agricultural issues and community need to see if the project will be utilized • Communities will need to be engaged to gauge societal acceptance • Agrivoltaic systems are most costly than ground mounted systems • There could be additional costs associated with the framing side • Agrivoltaic farms are a relatively new technology and there aren't many studies in the African context to assist with choosing the suitable crops • The shading from the panels may be detrimental to some crops as it may hinder the photosynthetic effect

Research Areas – Intervention opportunities

Waste to energy / waste recycling

- Solid waste incineration
- Anaerobic digestion for biogas production
- Landfill gas capturing
- Biogas production from animal waste
- Pyrolysis

Waste to energy / waste recycling

PROS	CONS
Municipal solid waste incineration - direct burning of waste at 900-950° to produce steam which is used to turn turbines to produce energy	
• Opportunity for Skills development and job creation • Reduces waste dumps and landfills • Suitable for handling **mixed waste** • No pre-processing is required	• Cleaner but still produces some GHG emissions • High set up cost • Requires well established waste management system, enviro monitoring for emissions • Developed countries moving away to cleaner technologies
Anaerobic digestion for biogas production - biogas is harnessed from anaerobic digestion in enclosed tanks to optimize the gas output.	
• Small sized biogas plants can be successfully implemented in developing countries • Could replace fossil fuels and wood • Inadvertently curbs deforestation as it reduces the need for firewood • Reduces greenhouse effects	• Only appropriate for organic matter, waste will need to be well sorted • Inorganic matter in the waste will hamper the process
Capturing of landfill gas - Landfill biogas is concentrated in methane and can produce heat and energy through cogeneration. Controlled landfills can be used to produce heat and electricity with a capacitor turbine generator	
• Reduces adverse climate effect of sanitary landfills • Potential for upskilling and job creation for maintenance	• Capture rates are low in developing countries due to technicalities and cost
Biogas from animal waste - Involves the conversion of animal waste (cows in this case) to create biogas using a small scale digestor. Household waste in anaerobic conditions to generate and collect biogas	
• Simple to develop and easy to scale up or down according to needs • Opportunity for upskilling and job creation • Low-cost energy for cooking and lighting • Biogas slurry can be used as fertilizer • Improved waste and wastewater management	• High upfront costs for construction, labour, equipment and installation • Requires adequate supply of matter and water. • Temperature dependent, biogas production decreases in colder weather • Incorrect operation and lack of maintenance due to lack of technical skills (especially in rural regions) and inadequate • Might not be accepted by communities since it involves the use of waste (adverse perception that it is unsanitary)
Pyrolysis - Plastic is converted into oil through pyrolysis and this oil is used as fuel for generators in order to produce electricity	
• Thermal decomposition of organic materials at relatively high temperatures in an oxygen limited environment • EPCM Holdings developed a modular, **plastics-to-fuel-oil** plant. The small scaled plant continuously processes 1.2 tons of plastic per day and produces various fuel oils.The resulting fuel oils can be used for power generation, fleet running or sold to bulk distributors for blending – resulting in a quick payback period and additional revenue stream. • Low air pollution compared to incineration	• Although it can potentially reduce the amount of plastic waste found in landfills and littered areas, pyrolysis of plastic is sensitive to the collection of adequate plastics, the quality of the plastic collected and the uptake of pyrolysis fuel on the market. • Need for pre-treatment of waste to produce pyrolysis oil from solid waste which is cost-intensive, and instability of pyrolysis oil to require additional treatments (like thermal processing and hydrodeoxygenation) for storage.

Waste to energy / waste recycling

PROS	CONS
Gasification- thermal decomposition in the presence of limited oxygen, which yields a mixture of gases	
• Opportunity for Skills development and job creation • Reduces waste dumps and landfills • Organic materials, containing mostly chemically bound carbon, hydrogen, and oxygen, are decomposed into syngas that can be utilised as various energy products, for example high quality fuel or electricity. • SANEDI commissioned NECSA to design and build a more environmentally friendly Plasma Waste Gasification (PlasGas) and Plasma Waste to Energy (PlasWen) systems. Current systems are designed to meet varying, site-specific user requirements, which range from technology demonstration units and vitrification of municipal solid waste (MSW) incinerator bottom ash to the production of syngas for electricity generation: ✓ Current systems are designed to meet varying, site-specific user requirements, which range from technology demonstration units and vitrification of **municipal solid waste (MSW)** incinerator bottom ash to the production of syngas for electricity generation. ✓ No combustion gases are produced typically generated in conventional autothermal reactors) ✓ The temperature in the reactor can be easily regulated by controlling plasma power and the material feed rate.	• Cleaner but still produces some GHG emissions • High set up cost • Requires well established waste management system, enviro monitoring for emissions
Composting – natural process of recycling organic matter, such as leaves and food scraps, into a valuable fertilizer that can enrich soil and plants	
• Handles high moisture content **organic material** (56%) • Proven technology • In the suburbs of larger South African cities such as Durban, Johannesburg, and Pretoria, there are community composting centers. Residents drop off their garden waste and it is composted and resold for household-sized gardens. In peri-urban areas throughout Africa, • Low capital costs • Public acceptance higher than waste to energy technologies	• Requires highly segregated organic waste - not a suitable technology for mixed waste. Highly dependent on pre-processing • Odour issues in case of improper aeration.
Waste Recycling Facility – separation of waste for recycling/ reuse purposes	
• Avoiding and reducing waste before discarding, these initiatives are regarded highest on the waste hierarchy. • Job opportunities. • Research conducted by Ayeleru, et al (2021), aims to determine the cost benefit analysis (CBA) of setting up a recycling facility for the complete diversion of MSW from landfills (so that the MSW can serve as raw materials for recycling industries, and thereby creating downstream jobs for the masses, and generating	• The economics of waste treatment and waste recycling facilities is not widely available in South Africa. • Low carbon emissions

Research Areas – Intervention opportunities

RDP housing

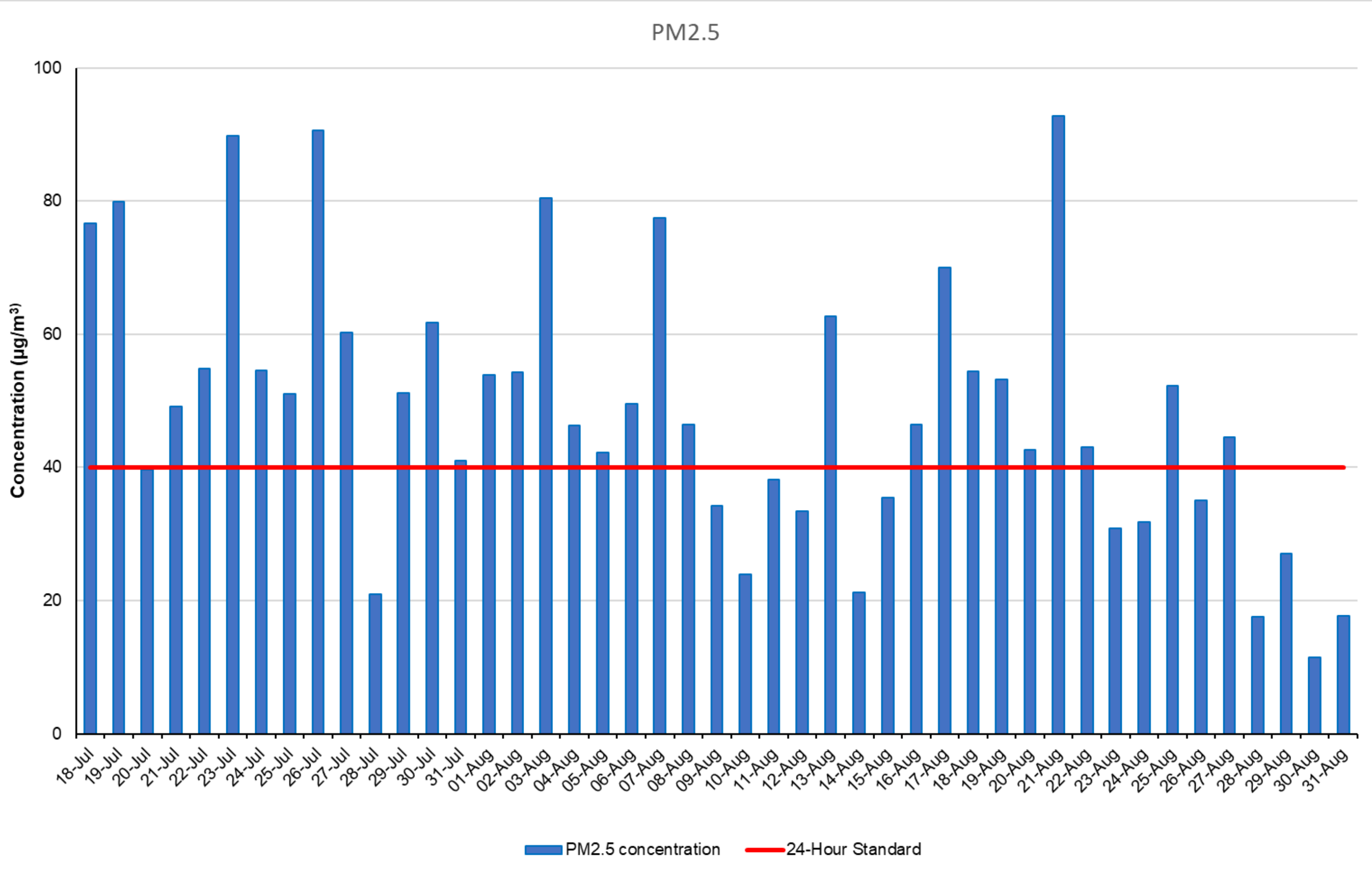
- RDP design aspects
- Thermal controls (insulation)
- Electricity use reduction

RDP housing design

PROS	CONS
Articulated wall design - Door and window openings are designed as units which are the full height of the walls which eliminates the need for masonry above windows and doors	
• Can eliminate the problem of cracks in masonry • Avoids the high cost of footing systems • If buttresses are needed, they can be used as shelves or cupboards • Eliminates the need for masonry above windows and doors	• Walls have to be structurally sound. • May require the use of buttresses to ensure walls are stable.
Roof and wall insulation – materials for heat retention and insulation	
• Cost effective and quite easy to build and integrate into design • Improves quality of life • Reduces heating requirements, in turn reducing electricity demand	• Some materials used for insulation, particularly cost-effective ones can irritate eyes, lungs and skin • Can cause moisture buildup causing issues with mold
Design elements – reduced window size (prevent heat from escaping), partitioning of rooms (smaller areas require heating), installation of ceilings and roof design (materials which insulate)	
• Smaller windows also offer privacy in addition to thermal control • Allows for the privacy of having separate rooms instead of one open space • Improves quality of life • Increases heat retention • Thermal control during warmer months reducing the need for cooling systems	• Smaller windows means less natural light, could increase energy needed for lighting • High initial costs • More important to keep the house warm during colder months
Energy use reduction – energy efficient bulbs, solar systems to run lighting and small appliances and solar geysers	
• Reduction in GHG emissions • Reduction in air pollution • Promotes sustainable development • Improves quality of life • CFLs are cost effective and efficient • Low maintenance • Can be co-opted as water purification (has been tested in a rural village in Iran) • Satisfies basic energy needs, even if areas are off-grid • Can be incorporated into RDP housing designs	• Life is reduced if constantly turned on and off (bulbs) • Contain mercury which is toxic if bulbs break or are not disposed of properly (bulbs) • Cannot endure outdoor elements (bulbs) • High investment costs in relation to the benefit that they provide (geysers) • Don't work well in winter (geysers) • Often not preferred since cheaper options are available to heat water (geysers) • No direct opportunities for job creation or income generation

Air Quality Monitoring – Pre and Post Intervention

Daily $PM_{2.5}$ concentration



Reporting Values	
$PM_{2.5}$	
Max	92
Min	11.5
Average	48
No. of exceedances	30

Lessons Learnt

- Local air quality improvements (in homes) but small to negligible impact on airshed
- Improved quality of living – better insulated houses reduces heating requirements, less time required to heat water, cooking, cleaner indoor air quality
- Gas and renewable energy sources have a role and are viable options, but cost and ease of access need to be addressed
- Opportunities to reduce waste and create job opportunities – seed capital and ongoing support required
- Opportunities to reduce carbon footprint – capture biogas, local solar grids, reduce burning of waste
- Each situation is unique

Thank You

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