Back Ground

- Since 2008 Axis has reviewed alternative green power technology both for backup and main power solution to support development of renewable energy sources which can reduce the use of petroleum-based fuel.

- To choose the best technology for every site condition Axis did comparisons on technology, the financial proposition and trials before deploying the power system in Axis network.

Comparison of Technologies

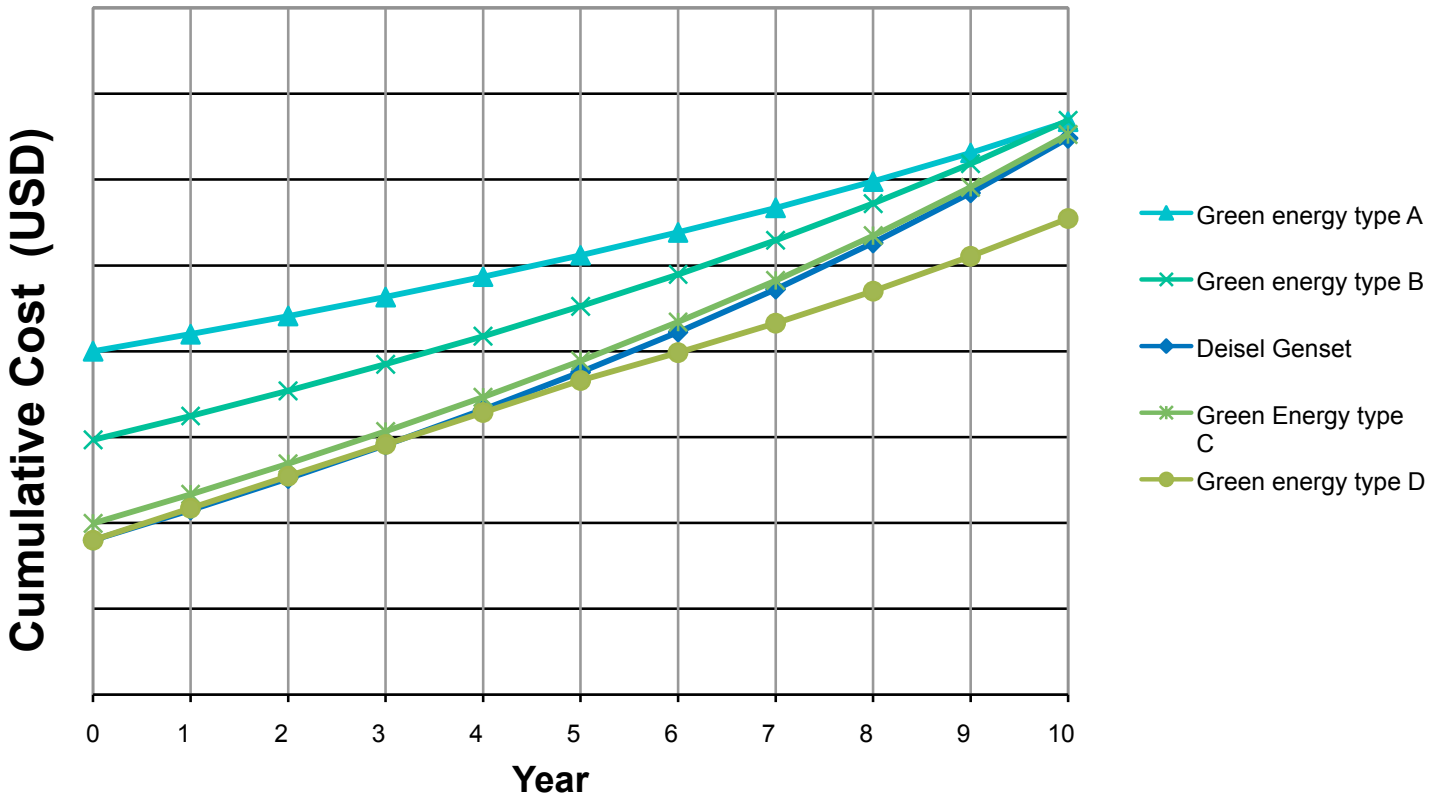
pacity	Hydrogen Fuel Cell	Methanol Fuel Cell	Diesel Genset	VRLA bateries	Solar Cell
Power generation technology	Electrochemical conversion	Electrochemical conversion	Electro-mechanical (engine)	Electrochemical conversion	Solar radiation to electrons convertion
Power output	DC	DC	AC (ATS and rectifier)	DC	DC
Autonomy	Several hrs but not limited if refueling	Several days but not limited if re-fueling	Several days but not limited if re-fueling	Several hours but not limited if there is secondary cell	Several hours but not limited by number of solar panels + battery capacity
Fuel type	H2 gas (99.95%)	Methanol/water (62%/ 38%)	Diesel	Chemicals (PbO2, Li…)	Solar Radiation
Fuel consumption	900 l/kWh or 1.8m3@2kW	1 l/kWh (2l@2kW)	around 3 liters/hr @ 10kW	AC power fpr floating/ recharging	N/A
Power density: kWh in a 50 liter storage volume	10 kWH	50 kWh	50 kWh	<8kWh	170 W/ m2
Fuel physical state	Gas	Liquid	Liquid	Liquid/solid	N/A
Fuel transport container	Stainless steel tank @150-200 bars	Plastic container or drum	Plastic container or drum	Plastic container - very heavy	N/A
Emission level					
CO2	0 g/kWh	700 g/kWh	>1500 g/kWh	0 g/kWh	0 g/kWh
CO	0 g/kWh	0.2 g/kWh	8.0 g/kWh	0 g/kWh	0 g/kWh
NOx	0 g/kWh	< 0.01 g/kWh	7.5 g/kWh	0 g/kWh	0 g/kWh
SOx	0 g/kWh	0 g/kWh	Significant	0 g/kWh	0 g/kWh
Particulate matter	0 g/kWh	0 g/kWh	0.8 g/kWh	0 g/kWh	0 g/kWh
Adaptability	High: indoor or outdoor installation	High: indoor or outdoor installation	Low: outdoor only	High: indoor or outdoor installation	Low: outdoor only and require wide spaces

Comparison of Technologies - continued

	Hydrogen Fuel Cell	Methanol Fuel Cell	Diesel Genset	VRLA bateries	Solar Cell
Modularity	High; possible to have up to 3 systems in parallel (5kW power modules)	High; possible to have up to 3 systems in parallel (5kW power modules)	No modularity	High	High
Maintenance	Very low (clean air filter once a year)	Very low (clean air filter once a year)	High (filter, oil change…)	Very low	Low
Fuel toxicity	None	Low	Medium (diesel spills)	High	None
Bio fuel availability	No	Yes	No/Yes - storage issues (Biodiesel decomposes after a few months)	No	Not Required
Theft potential	Very low	Very low	High	Very high	Low
Expected life time (@400 hrs/ year)	10+ years	10+ years	10 years	1 to 3 years	Solar panel is 20 years, Battery is 3 years
Weight (for several days autonomy)	Fuel cell = 170 kg + 60 kg per gas cylinder (4 hrs of autonomy per cylinder)	Fuel cell = 280 kg (fuel = 200 kg)	More than 1000kg with fuel	Several tons (for large battery banks)	More than 1,000 kg
Suitability for rooftop installation	No (H2 gas problem)	Yes	No	Yes (weight could be a concern for large battery)	Yes but require large spaces
Vibration	No	No	Yes	No	No
Noise level	< 65 dB @ 1m	< 65 dB @ 1m	70 dB at **7** m	0 dB	0 dB
Unit Footprint (W x D x H)	1.1 x 0.9 x 1.25 m	1.4 x 1.1 x 1.7 m	2 x 1 x 1.4 m (excl. fuel tank)	Varies on backup time	For 800 W need 24 m2
Hours of operation until main overhaul	5000 hours	5000 hours	4000 hours	800 to 1000 cycles	Not required
Electrical connection in standby	75 W	250 W	None	recharge according to power availability	None

Financial Proposition

Sample of TCO Comparison
Back up power 2.5 kW with 360 hours backup per year



Green Power Technology Classifications

Based on comparisons on technology, financial proposition and trials, Axis has classified:

- For off-grid sites, to use solar cell or hybrid solutions
- For sites with limitations in relation to grid capacity/ quality and easy access to use Hydrogen Fuel Cell or Methanol Fuel Cell or VLRA batteries
- For sites with limitations of grid capacity/ quality, difficult access and has a history of community issues, to use Methanol Fuel Cell or VLRA batteries

Green Power Technology Deployment

So far Axis has deployed:

- 1 unit of Solar Cell for off-grid sites in Dumai, Riau, with up to 800W load and the site configuration is outdoor 2G (2+2 BTS) plus microwave backhaul
- 1 unit of Hydrogen Fuel Cell in Jakarta Region which is rated up to 3kW output, and consumes 2.7 m^3 per hour at full load (3.5 hours per 50l cylinder) and the site configuration is indoor (2+2+2 BTS) plus microwave backhaul
- 20 units of Methanol Fuel Cell in Jabodetabek, West and Central Java which are rated up to 2.5kW output and the site configurations are indoor 2G+3G and outdoor 2G+3G plus microwave backhaul

Operations and Maintenance (OM)

- For operations and maintenance Axis does direct OM for solar cell and hydrogen fuel cell, and outsource OM to the original supplier for methanol fuel cell.

- All the applied green power technology solutions have achieved the SLA defined by Axis and down time has reduced, in some cases to zero down time. The solutions have also proved to be more reliable, much simpler maintenance and reduced community issues.

- The application of green power technology in the Axis network has helped Axis to reduce the opex and at the same time improve revenue.

Axis Green Power – Solar Cell

RUBE005 Minas Barat, Riau

JL YOS SUDARSO KM 47 RT 01 RW 04 KEL MINAS BARAT KEC MINAS KAB SIAK PROP RIAU



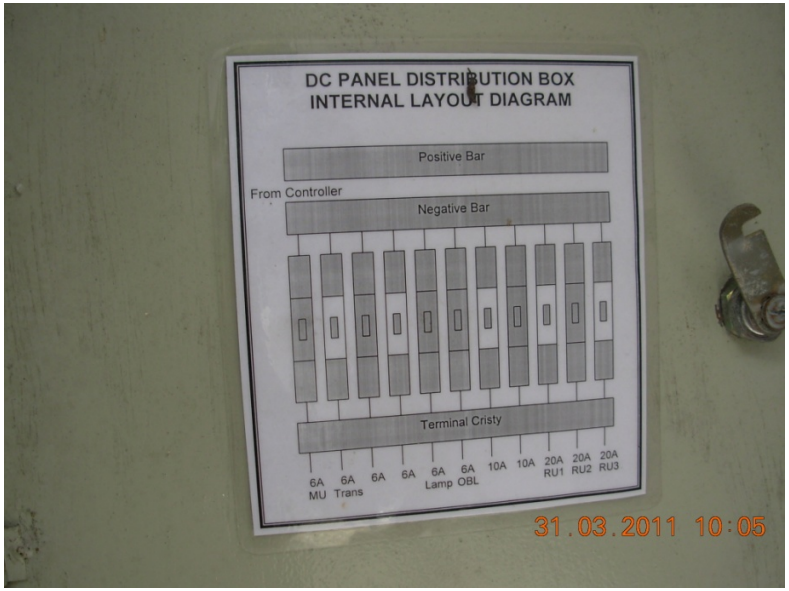
- Has provided uninterrupted zero pollution prime power
- The system is engineered for up to 800W load
- Site configuration is outdoor 2G 2+2 BTS plus microwave backhaul

- Project Management by AXIS
- No service interruptions

Axis Green Power – Solar Cell









Axis Green Power – Fuel Cell

SRG028-Bumi Jaya Ciruas, Serang- Banten





- Project Management by AXIS
- No technical issues

- AXIS integrated a commercial fuel cell into an existing BTS site, to provide zero pollution backup power
- The fuel cell is rated 3kW output, and consumes 2.7 m^3 per hour at full load (3.5 hours per 50l cylinder)
- Site configuration is indoor 2G 2+2+2 BTS plus microwave backhaul

Axis Green Rollout – Fuel Cell

SRG028-Bumi Jaya Ciruas, Serang- Banten







Fuel Cell Methanol 20 sites

Jabodetabek and Central Java

- AXIS integrated a commercial fuel cell into an existing BTS site, to provide reduce pollution backup power, and elliminate community issues
- The fuel cell is rated 2.5kW output, and consumes 2.2 liters per hour at full load
- Site configuration are indoor 2G +3G and outdoor 2G+3G plus microwave backhaul



- Project Management by original supplier
- No technical issues











THANK YOU