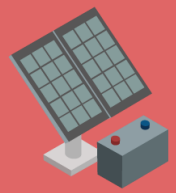
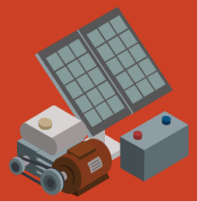
Mini-Grid Technologies

	 Micro/mini hydro	 Solar-battery	 Solar-battery + diesel	 (solid) Biomass gasifier	 Wind-battery	 Diesel
Range of investment cost USD/kW (generation, distribution)	**500 - 10,000**	**4,000 - 7,000**	**5,000 - 10,000**	**1,500 - 10,000** (gasifier, cleaning system, heat exchanger, gas genset, grid)	**4,500-13,000**	**400-1,000**
Pure O&M cost (assuming overall system lifetime of about 20 years; without depreciation) as % of investment (depends on equipment quality; battery and diesel genset replacement to be included)	**2-5 %**			**min 10%** without fuel cost; daily maintenance required!	**5-15%** (wind turbine to be replaced in 20 year period!); turbine service once a year **→ highest O&M cost among RE!**	
Range of cost (LCOE) in US Cent per kWh	**5-30**	**40-100**	**50-100**	**5-50 (biomass cost!)**	**60-100**	**60-120 (fuel price and transport!)**

Percentage of local contribution (equipment and installation)	**40-70%**	**5%**	**5%**	**30%-95%**	**20-40%** in community **50-90%** in country depends on country; parts like charge controller, batteries, inverters etc. often imported	**5%**
Local availability of spare parts	**+++**	**-**	**-**	**++**	**+** Depending on country (normally all spare parts can be sourced locally except magnets)	**++**
Resource assessment	Measure water level (min 1 year) and flow	Data from ... database worldwide available?		Collect data on agro residues for at least 3 years (supply chain!); make forecast Seasonality important to consider!	Measure wind speed (minimum 1 year)	Accessibility for diesel transport and affordability of diesel
Typical cost driver	Low head - high flow (more expensive than reverse) Complicated civil works (difficult terrain) Long distance betw. hydro site & supply area	Battery component (high investment x USD per... every y years)	Battery + cost for diesel fuel	Biomass fuel price Gas cleaning system Quality of gasifier (insulation etc.) level of automatisation	Required battery capacity depending on volatility of wind resource	Local price of diesel fuel

System design in view of scalability / modularity	Design based on available flow and (future) community demand Identify sufficient/big consumers (productive use) to increase load factor over 24 h Investment cost nonlinear to system size	Design for maximum harvest of kWh to reduce investment cost; especially private developers tend to undersize system to reduce investment risk; later extension (+/-linear cost increase)		good modularity (often several units from beginning to allow for maintenance)	often expanded with PV (better modularity); investment cost nonlinear to system size	Later extension difficult??? Oversizing has very negative impact on efficiency and fuel consumption
General advantages	If flow is sufficient, no storage required Low cost per kW and per kWh Local added value; can become cash cow in case of later grid connection Possibility of direct drive	Abundant resource in particular in dry climates (Africa) scalability of PV modules (BUT not for batteries!)	Flexibility through diesel back-up	Easy storage (biomass or gas can be stored, allows to operate at optimum efficiency) possible additional benefit for biomass vendors Less emission of particulate matter compared to other solid fuels	local manufacturing of wind turbines (also leads to lower O&M cost!) **complementary source to solar PV or diesel**	Independent of availability of RE resources
General limitations	Lack or seasonality of flow Access to funds for high initial investment	Lack of irradiation access to funds for high initial investment Limited scalability of batteries (parallel lead-acid batteries)??? Environmental impact of batteries	Access to funds for high initial investment Access for diesel supply High operational cost for diesel	technology less mature than others (early commercial stage) Thorough resource assessment required supply chain for biomass competition with food, dung etc. Natural biomass not	high spatial and temporal variability of the resource High maintenance requirements **Due to high variability of wind, unreliability of wind turbines and drop in PV prices, wind becomes**	CO_2 emission and environmental impact! Long term price increase of fuel

				pollutant, but: Deficient operation leads to generation of tar from cleaning system; can be problem	**complementary source to save fuel or generate at night or during winter/rainy season**	
Productive end use	Direct drive e.g. of agro processing machines possible Lower LCOE attractive for end use	Due to resource peak in dry season, very appropriate for irrigation		Heat (or cold) and electricity can be used! Agro enterprises that produce the biomass resource Used for various mills and local industry		

Developed by:

skat_ Swiss Resource Centre and Consultancies for Development

References:

International Renewable Energy Agency (IRENA)
Swiss Resource Centre and Consultancies for Development (Skat)
Trama TecnoAmbiental (TTA)
Wind Empowerment
Winrock International