

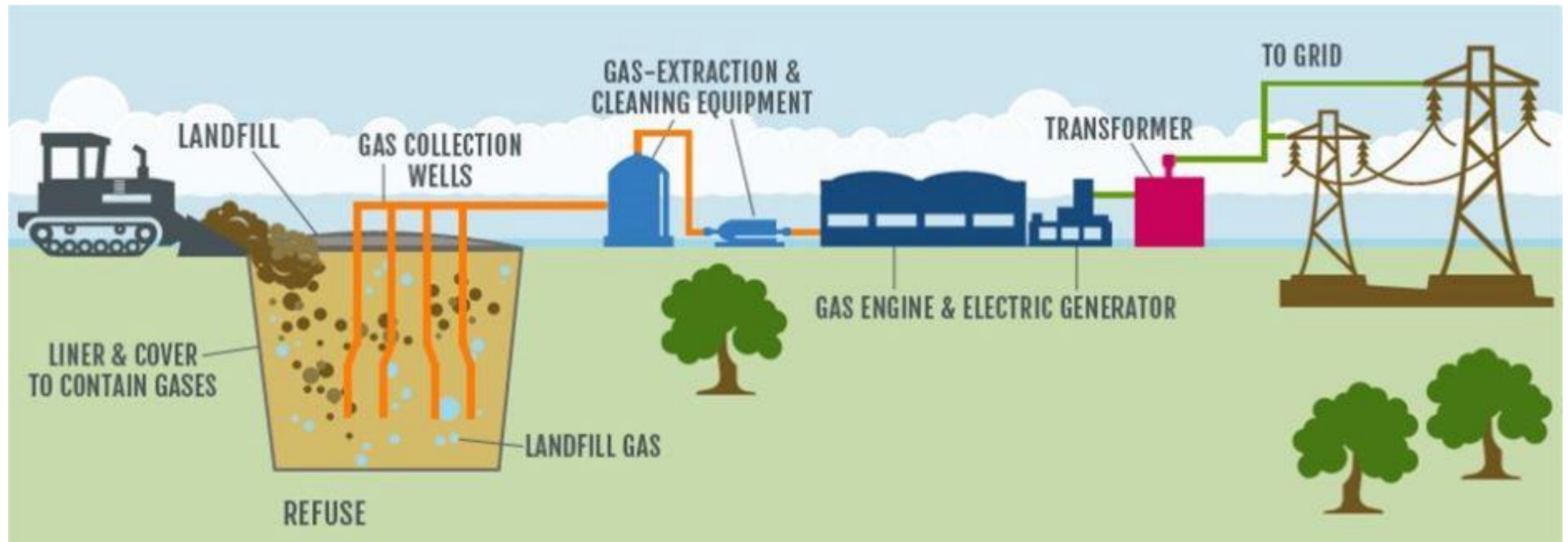
Off-Grid Landfills

Sze-Fei Peng

Principal Environmental Engineer



Landfill Gas as an energy source

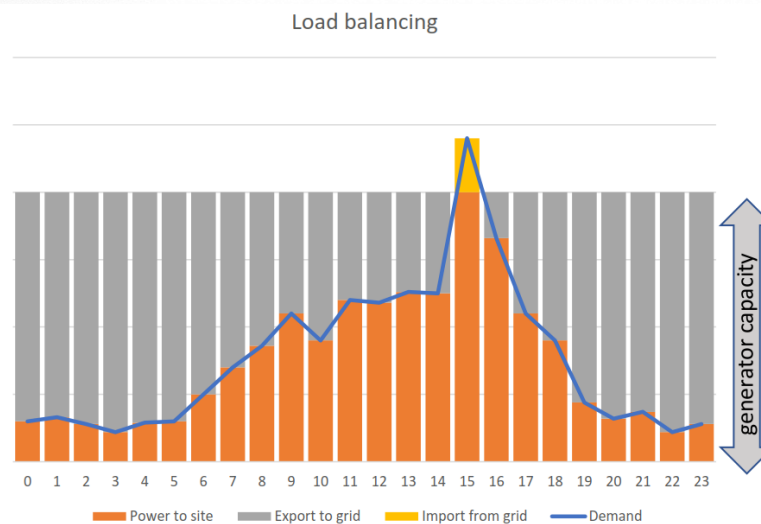
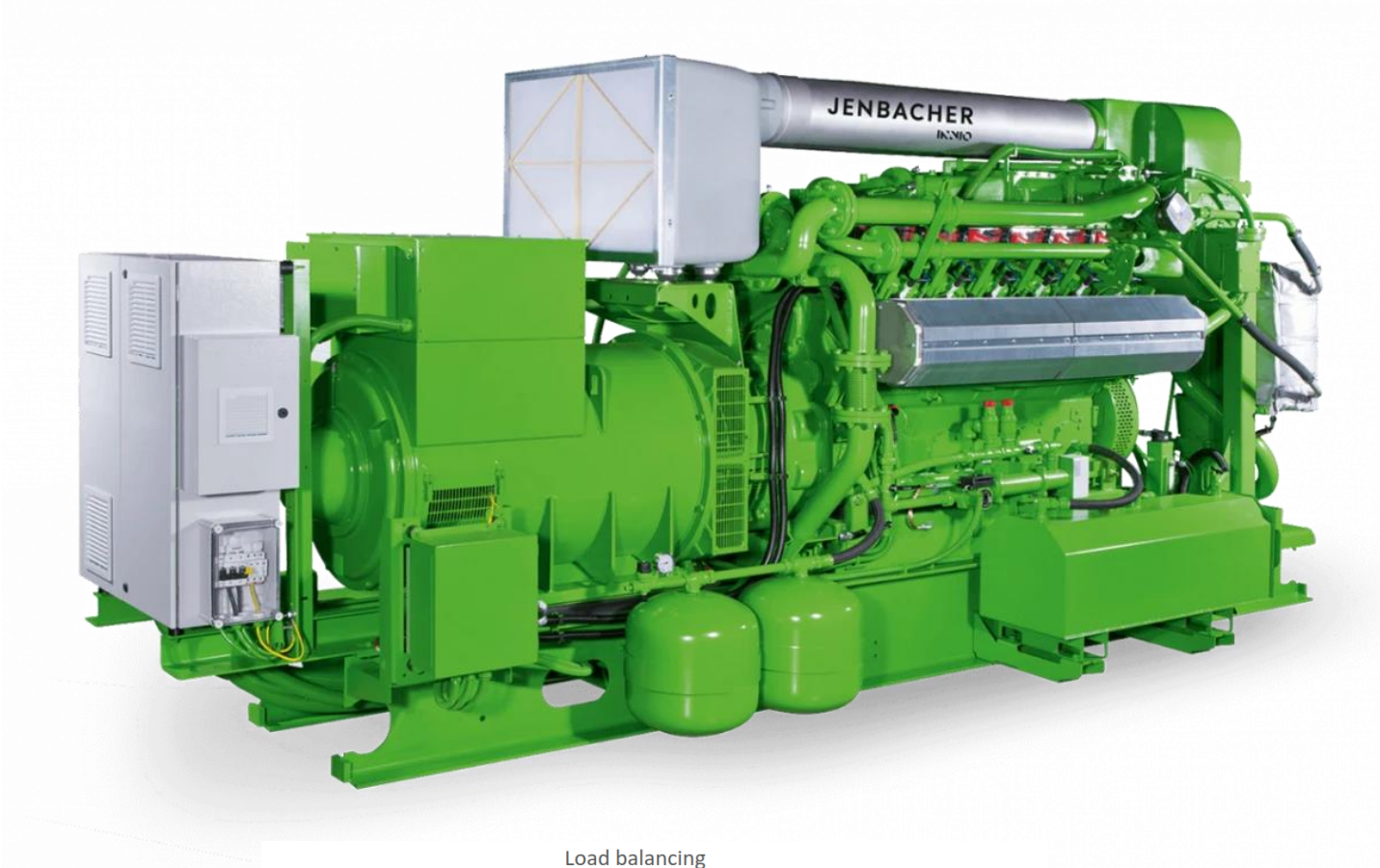


Larger Landfills

Reciprocating engines

- 200 kW to 10MW power output range
- 500 m³/hr or more landfill gas for 1.1MW engine
- >40 %v/v methane
- Close to power grid

1M tonnes of waste → 2.5Mm³ methane → 10,000MWh electricity per year



Rural Landfill

- Smaller tonnages
- High organics diversion
- Far from grid/ connection upgrade needed

→ Flare



Load Requirements

- Weighbridge
- Leachate pumps
- Aerators
- Blower/ flare
- Wheel wash
- Office / kitchen
- Cardboard compactor

Total Peak = 120 kW

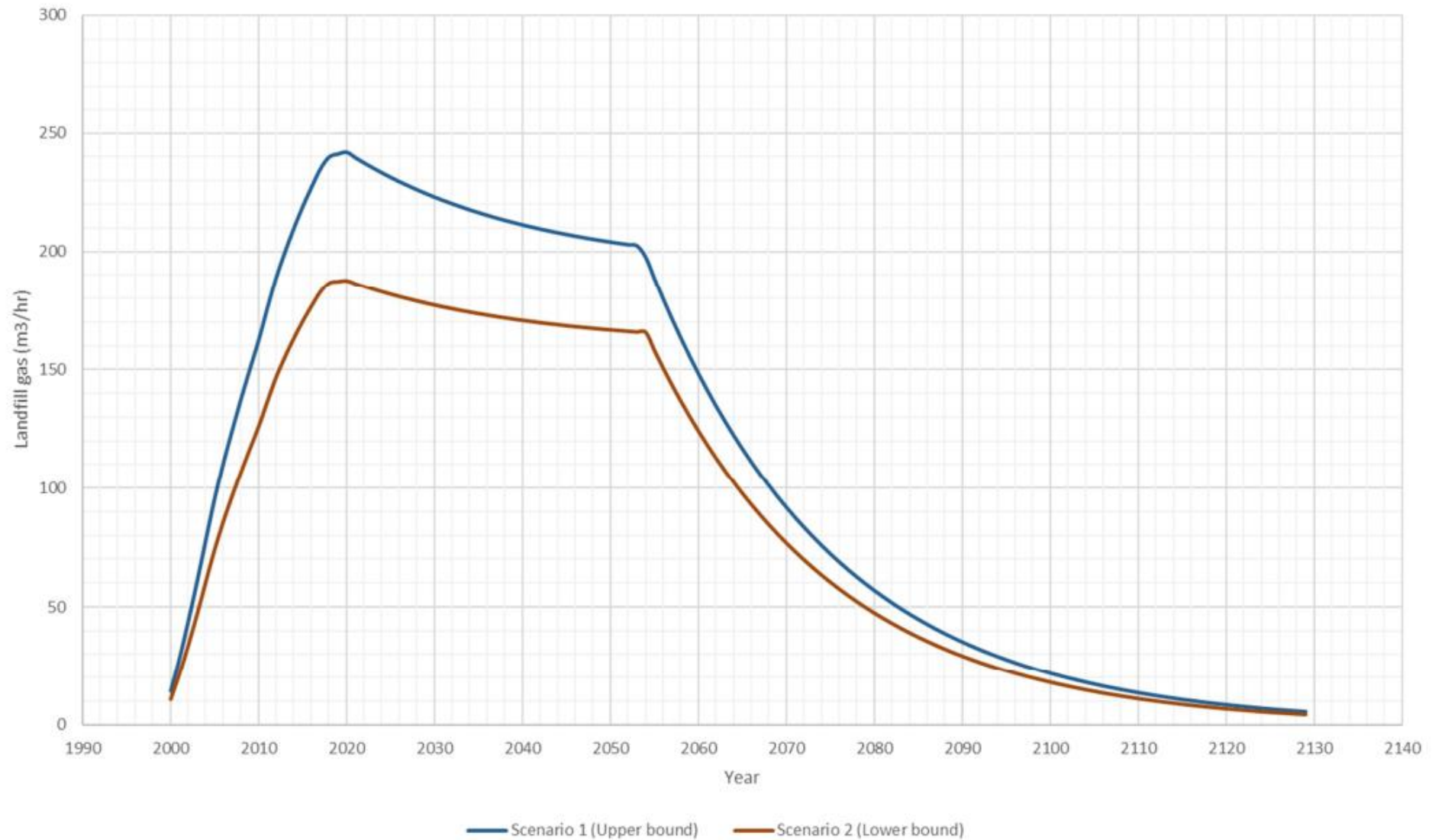


Power Sources

- Mains power – single phase 8.5 kW
- Diesel generators – 5 units



Landfill Gas Generation Curve





Landfill Gas Capstone Microturbines

- Landfill Ambiente, Italy
- Landfill Kupferzell, Germany
- Landfill-8 CHP, France
- Landfill-12 CHP, California
- Landfill Taiwan
- Landfill Sauk County, Wisconsin



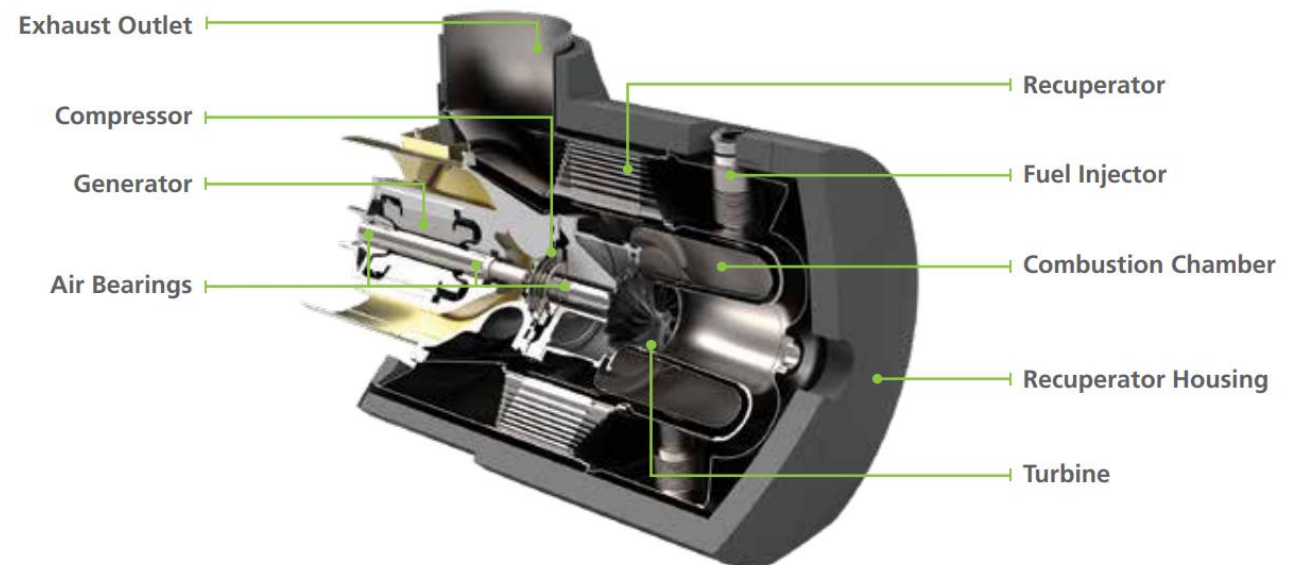
Capstone Microturbines

- Min. landfill gas 80 m³/hr
- Methane 30 to 65%
- Generates 65 kW /unit
- Scalable up to 30MW
- Able to support PV integration or grid export
- Leachate evaporation
- Siloxane removal
- Gas compression



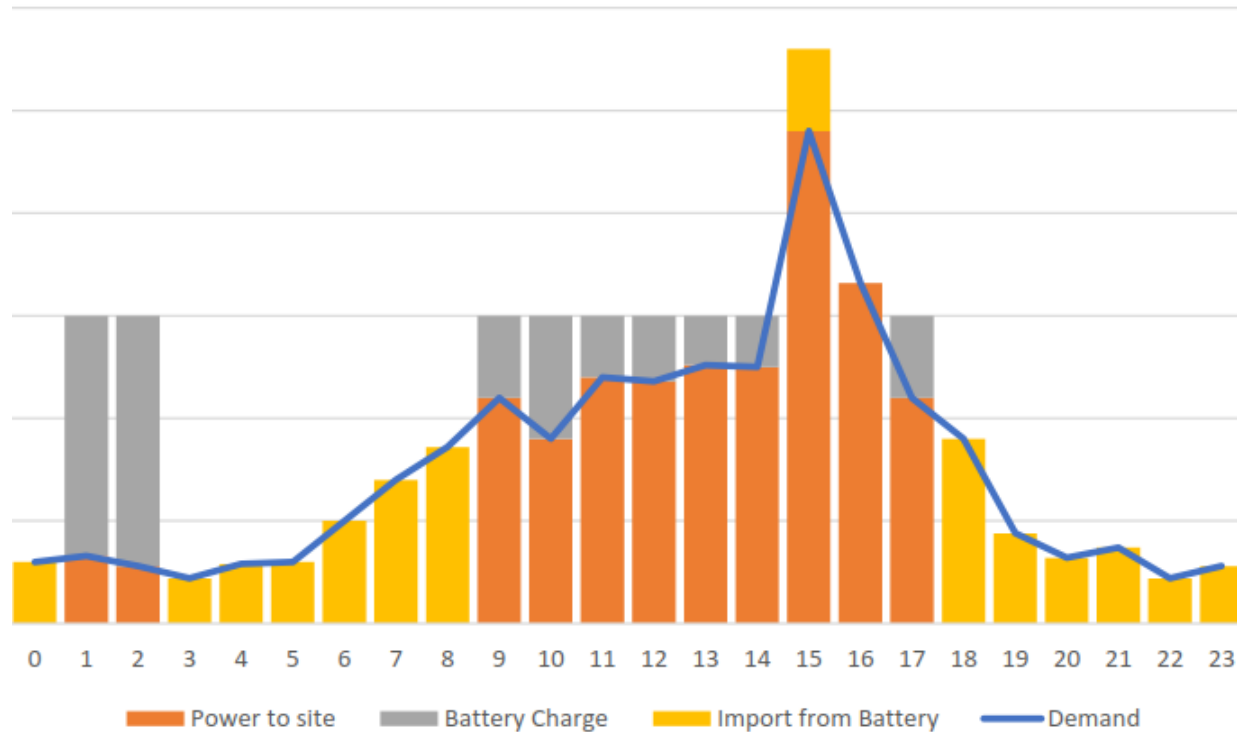
Microturbine technology

- One moving part – shaft spins on air bearings
- Air provides lubrication and cooling
- No oil or water cooling required

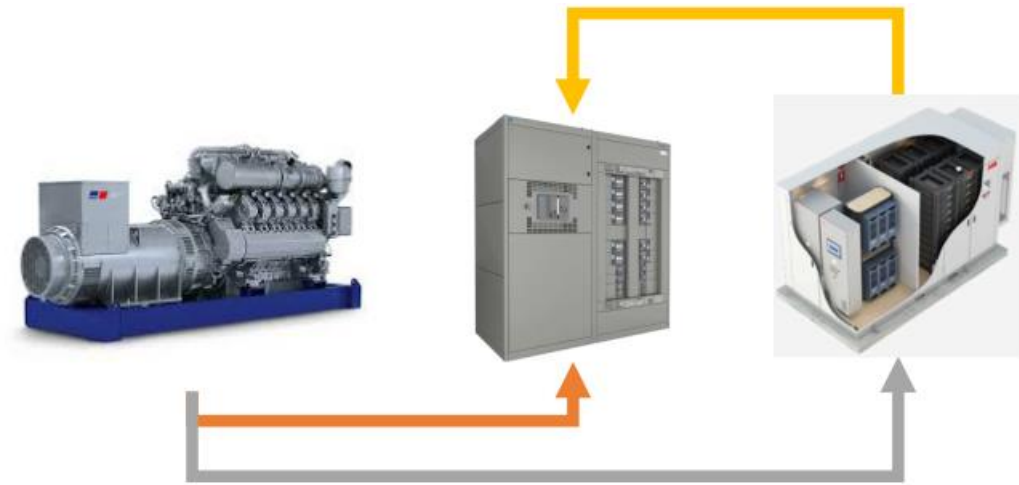


Battery replaces grid

Load balancing: engine and battery

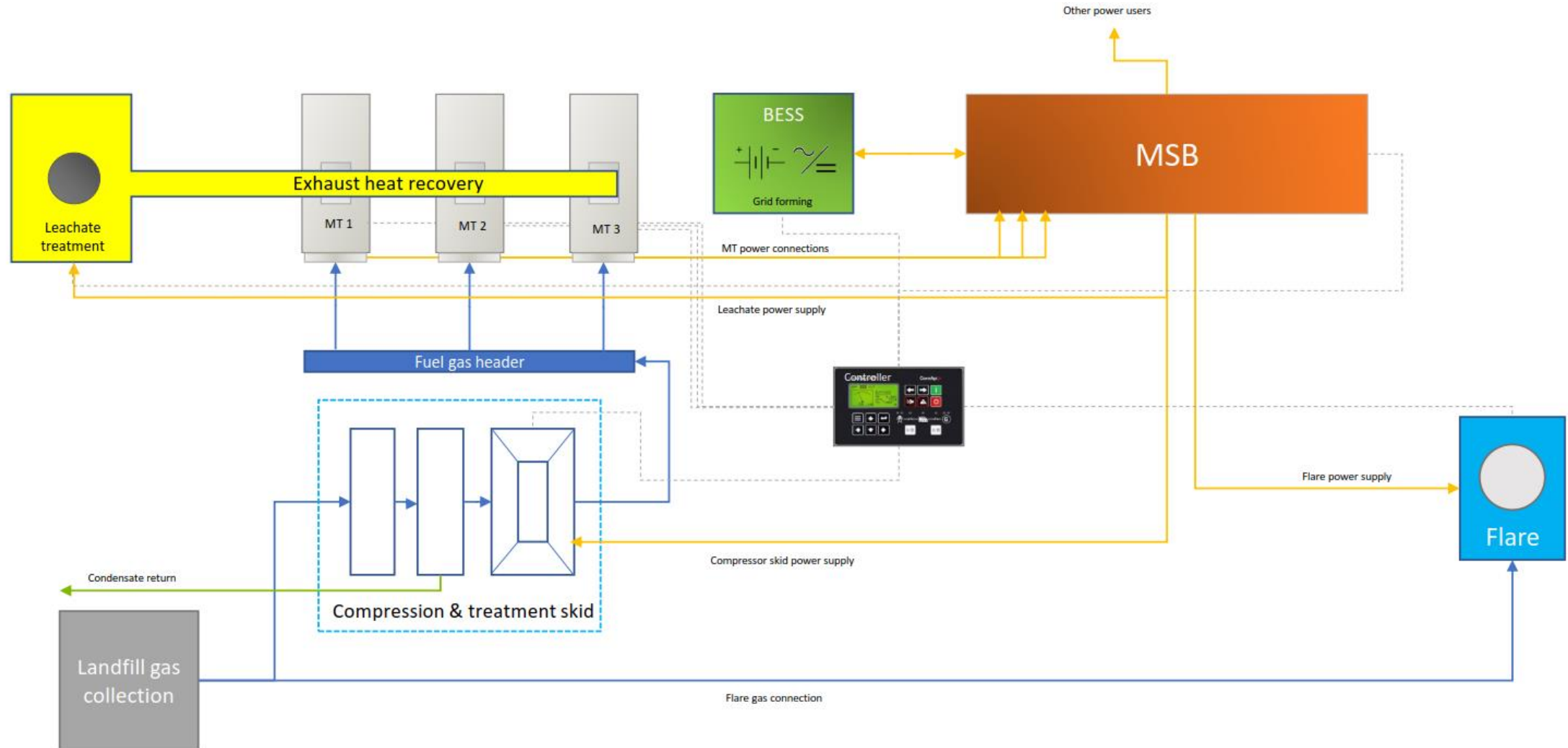


generator capacity



- Grid reference
- Energy storage and delivery that replicates grid.
- Supports large changes in load.

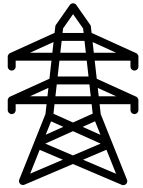
Solution Conceptual Design



Design Considerations

Design Consideration	Concern	Addressed	Mitigation
Availability	Major	✓	Microturbine and microgrid can operate under wide range of conditions. Back up from grid if required.
Reliability	Major	✓	Modular generation and compression systems increases system redundancy.
Maintenance	Major	✓	FPP options available for turbines and compressor provide confidence in cost and runtime.
Safety	Major	✓	Continuous landfill gas composition monitoring and Optimal developed control systems ensure safe operation.
Emissions	Major	✓	Microturbines achieve complete methane destruction, with minimal associated NO _x , SO _x , CO and VOC's.
Flexibility	Moderate	✓	MTs can run down to 50% load of one turbine, battery supply can support lower loads as needed.
Fuel Quality	Major	✓	MTs can accept fluctuations with methane concentrations of 30% to 65% without issue. Treatment system matched to fuel quality.
Power Quality	Major	✓	Additional harmonic filtering included in budget cost
Noise	Moderate	✓	Microturbine noise emissions are reduced thanks to lack of low frequency noise and vibration levels.
Future Expansion Capable	Moderate	✓	System has been designed to accept future generation and storage capacity.

Cost Considerations



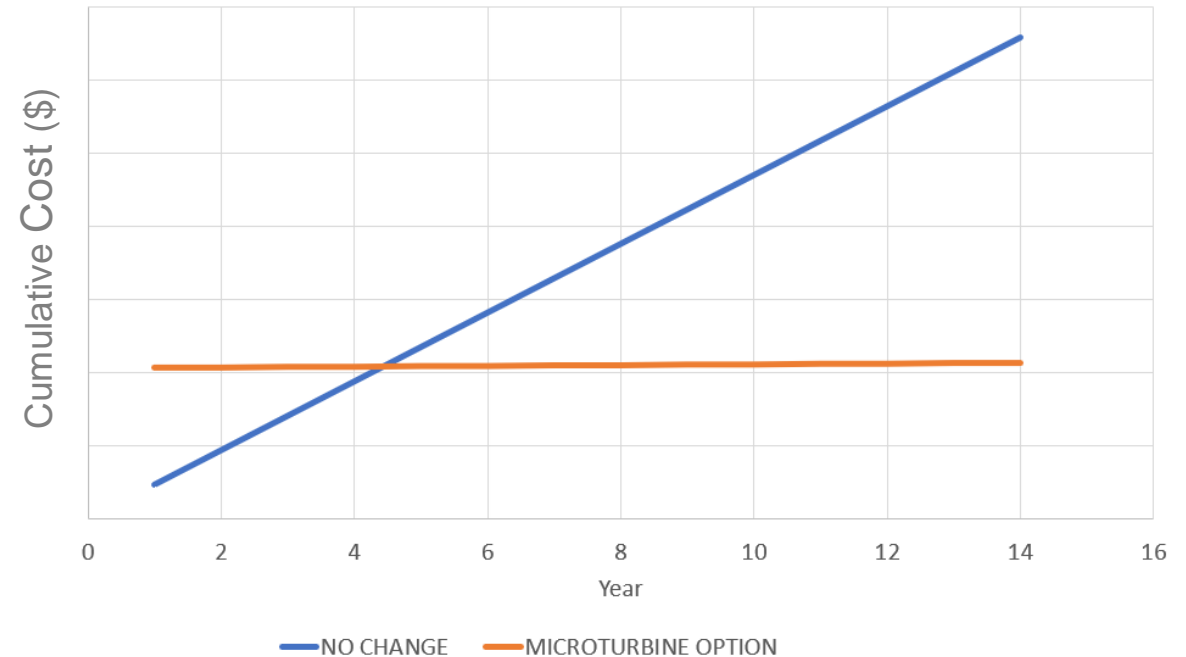
- Grid Power
- Diesel generator hire
- Diesel fuel



- Microturbines 3 units
- Gas compressor/ conditioning
- Battery

Payback in approx. 5 years.

894 tonnes per annum CO₂ eq. avoided



Benefits



Eighteen C65 microturbines running on methane gas generate power and heat at La Ciotat Landfill in France.



Provides secure reliable power



Competitive cost to current energy sources



Zero fuel cost



Net zero emissions
(5,300 trees/yr. saved)



Low impact (noise, air)



Additional power available for vehicle charging or other opportunities



Sze-Fei Peng: speng@tonkintaylor.com.au