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renewable energy solutions

Application of H2 to Achieve Higher Energy Efficiency in Power Generation in Smart Grids

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DLRE is a global energy company. Our team is expert in state of the art solutions that provide electricity to all required needs.

Offers services and solutions for Smart Micro-grids

- Project Aggregator
- Energy Solutions Consultancy
- Energy Project Financing
- Knowledge Transfer Programs for Local Maintenance Workforce
- Industry and Research Institute Collaboration

Delivering value for our clients

Risk Reduction
Through proven, high quality, modular and scalable solutions

Rapid Implementation
Mature process, consistent approach and professional people

Future Proof
Access to Innovation through industry and research collaboration

Key Facts

54 MW
Total installed micro grid generating capacity

108 MWp Solar PV & 42MW Wind
Installed Generation Capacity

USD 310 Million
Total value of projects implemented

8
Countries in Asia and Africa

> 20,000
Total households served

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Hydrogen as Secondary Fuel in Diesel Engines

Hydrogen: characteristics and benefits

Characteristics Compared to Diesel	▫ Higher ignition temperature, 500 ^{o}C ▫ Higher flame speed, burns 9 times faster than Diesel ▫ Higher diffusion speed, diffuses almost 20 times faster than Diesel ▫ Higher flammability limit, 10 times higher than Diesel
Enhancement of the engine operation	▫ Higher thermal efficiency at same brake power ▫ Reduction of CO emissions ▫ Reduction of Total Hydrocarbon (TCH) emissions ▫ Reduction of smoke and soot emissions ▫ Reduction of noise
The Results	▫ More than 25% of net fuel savings in all testes in different engines and conditions ▫ Reduction of CO, SO_X , NO_X and particulate matter ▫ Eliminates carbon deposits ▫ Lower maintenance costs

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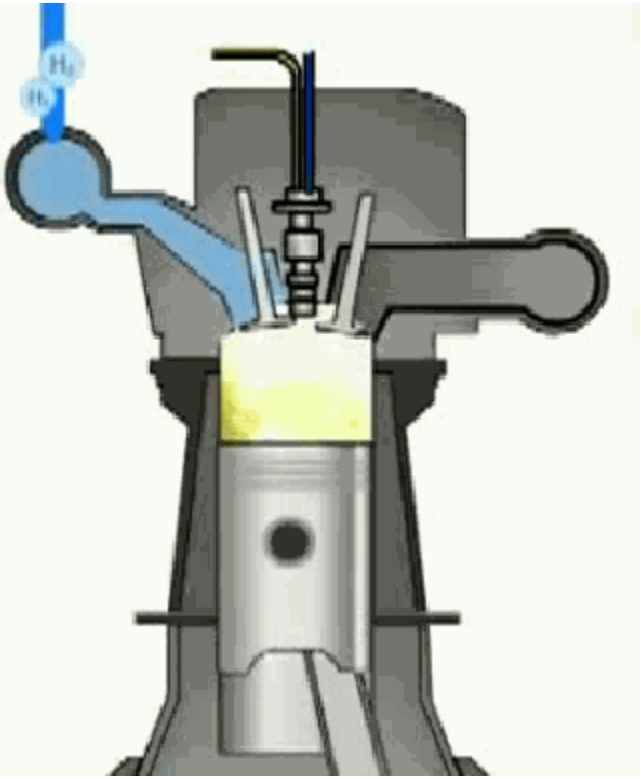
Hydrogen-mixed Diesel Engine

Working Mechanism

- Hydrogen is injected into the air intake of a diesel engine before entering the combustion chamber
- Hydrogen disperses through the air
- Diesel fuel is injected and starts to burn
- The hydrogen starts to burn
- Hydrogen burn spreads through the mixture 10x faster than diesel
- Hydrogen accelerates the diesel burn
- Ignites the diesel through the entire mix



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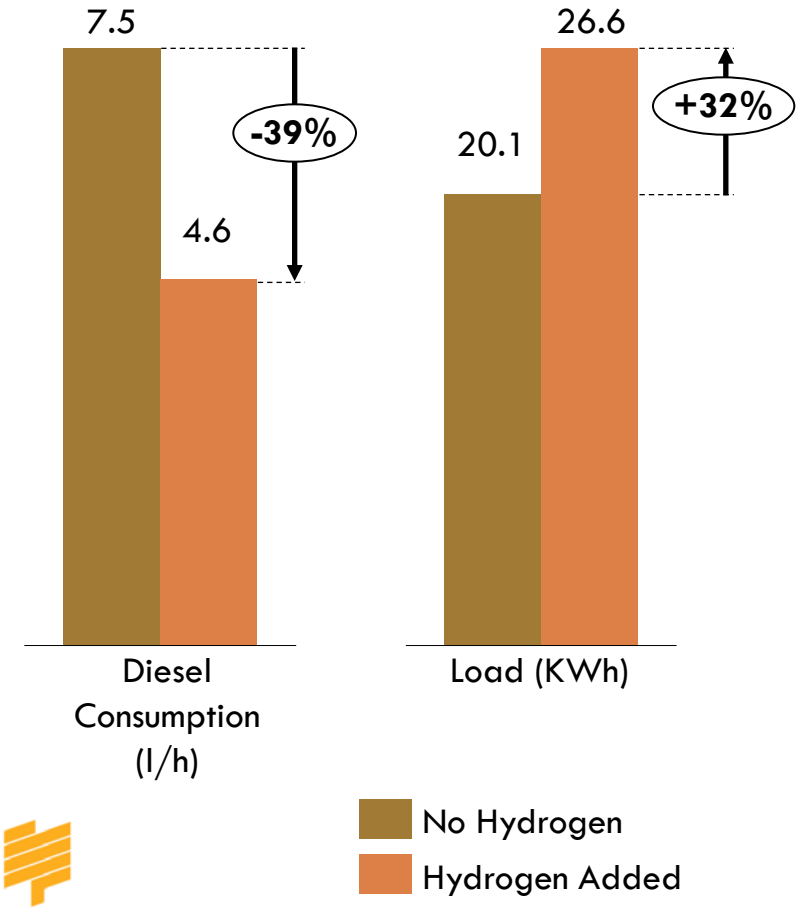
Hydrogen Injection into Diesel Engines

Experimental Results

Field Results
(35 KVA Genset & Electrolyzer, Pulau Ubin Micro Grid Test Bed with 20kW Load)



Experimental Results
(Reported in the literature)

Research	Fuel saving	Smoke reduction	CO reduction	CO2 reduction
Saravanan et al (Renew Energy 2008)	17%	35%	30%	33%
Jiang et al (Combust. Sci. Technol. 2010)	15%	31%	26%	37%
Karagoz et al (Int. J. Hydrogen Energy 2015)	13%	24%	16%	21%

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Hydrogen Applications for Power Generation

Industry in a Learning Curve

Industry Challenges

- Safety concerns
- Misconception about the applications and benefits
- Lack of specialized personnel capable to support installations and operations
- Concerns about engine operating conditions and continuous operations
- Business models

Benefits

- Lower fuel consumption per KWh
- Improvement of engines maintenance demands
- Improvement of engines life span
- Lower operating costs
- Lower emissions per KWh

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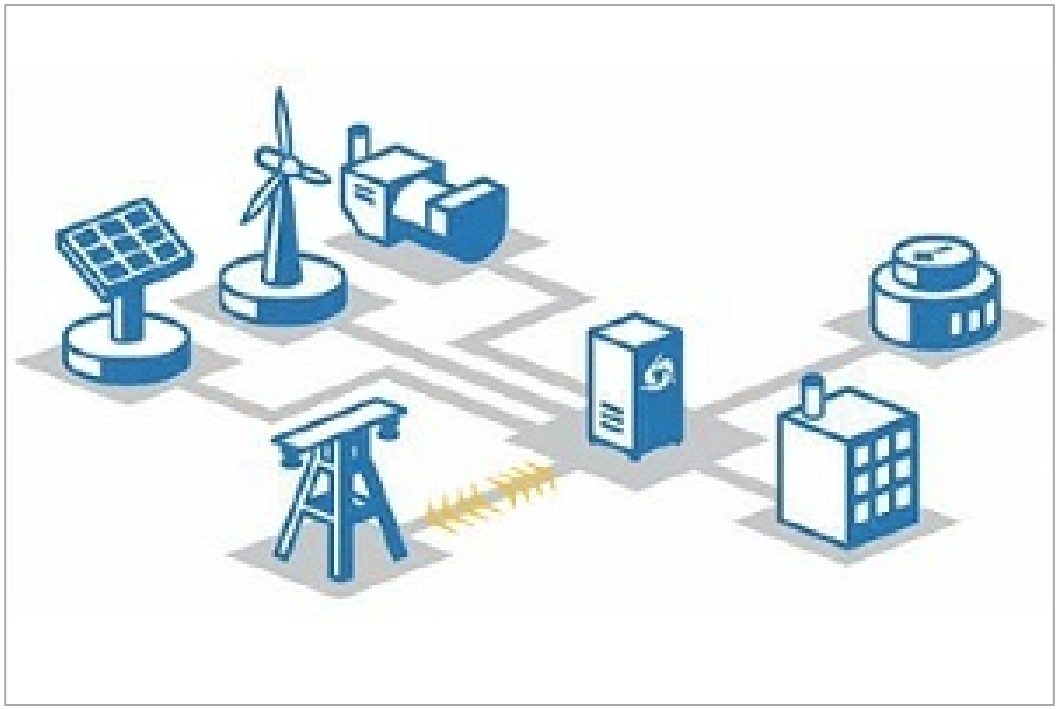
Applications in a Smart Grid

- Integrated controller (DG + H2 + ESS + RE)
- Real time response to variable loads to achieve lowest LCOE



Reduce Emission
More complete combustion and better engine performance

Lower Total Cost of Ownership
Reduce diesel and generator maintenance

Greater Access to Energy
More efficient systems with power quality

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