

MICROGRID APPLICATIONS



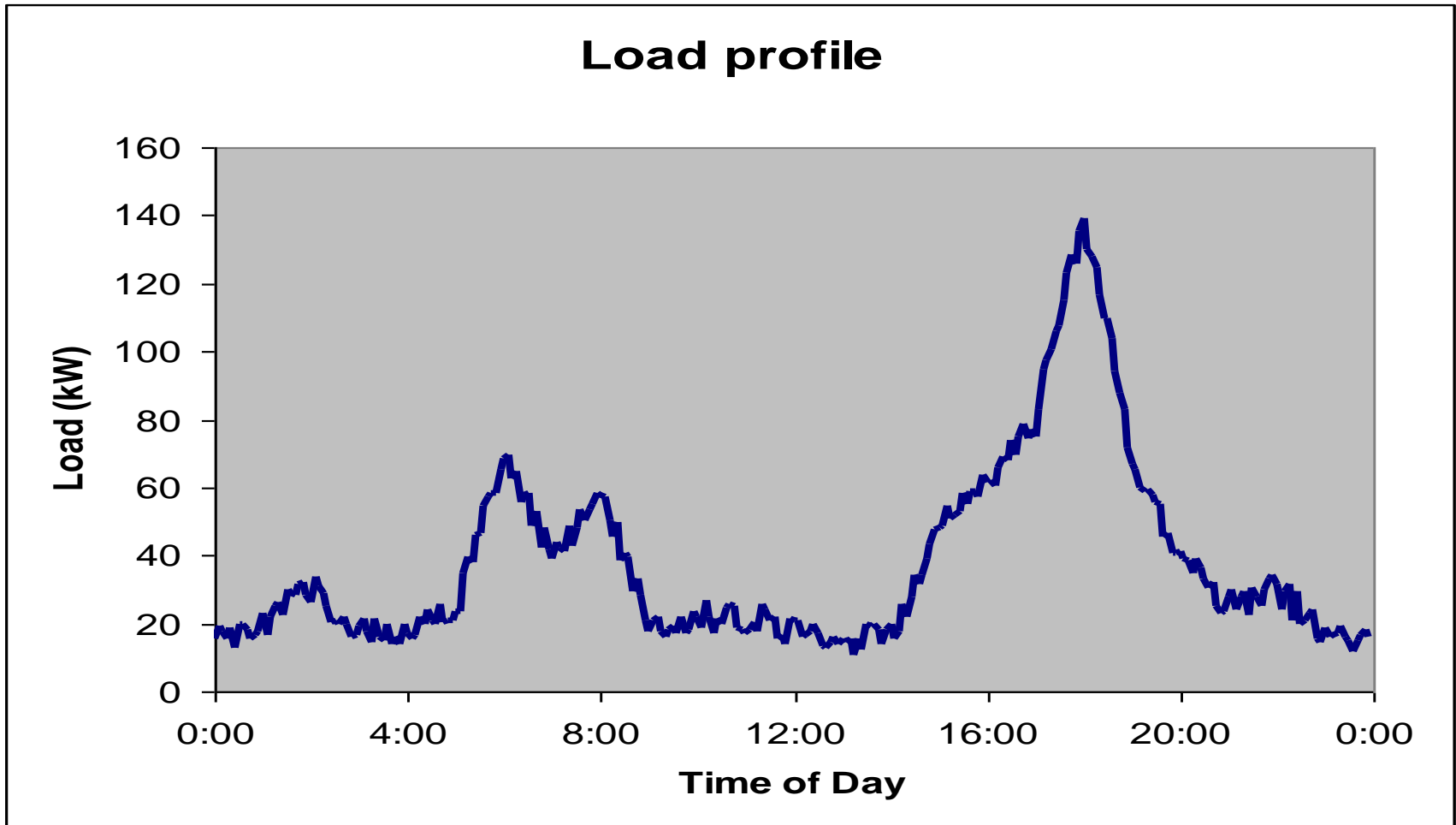
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TECHNOLOGY ADVANCEMENT

- ❖ HybridGEN™ Variable speed generator to provide the Micro Grid platform with a stable and efficient power generation source
- ❖ Enabling "Just-in-Time" energy production concept with Power Electronics
- ❖ Allowing high penetration of renewable energy
- ❖ Scalability: 20kW – 100MW

AN EXAMPLE OF A TYPICAL LOAD PROFILE FOR MICRO GRID



CONVENTIONAL ENERGY GENERATION

- Inflexible
- Poor fuel efficiency if base load and peak load vary
- High cost in transmission over long distances
- High Operation & Maintenance cost

'JUST-IN-TIME' ENERGY PRODUCTION CONCEPT

- ✓ Load Following: Fits the energy demand load profile
- ✓ Wastage reduced to the minimum

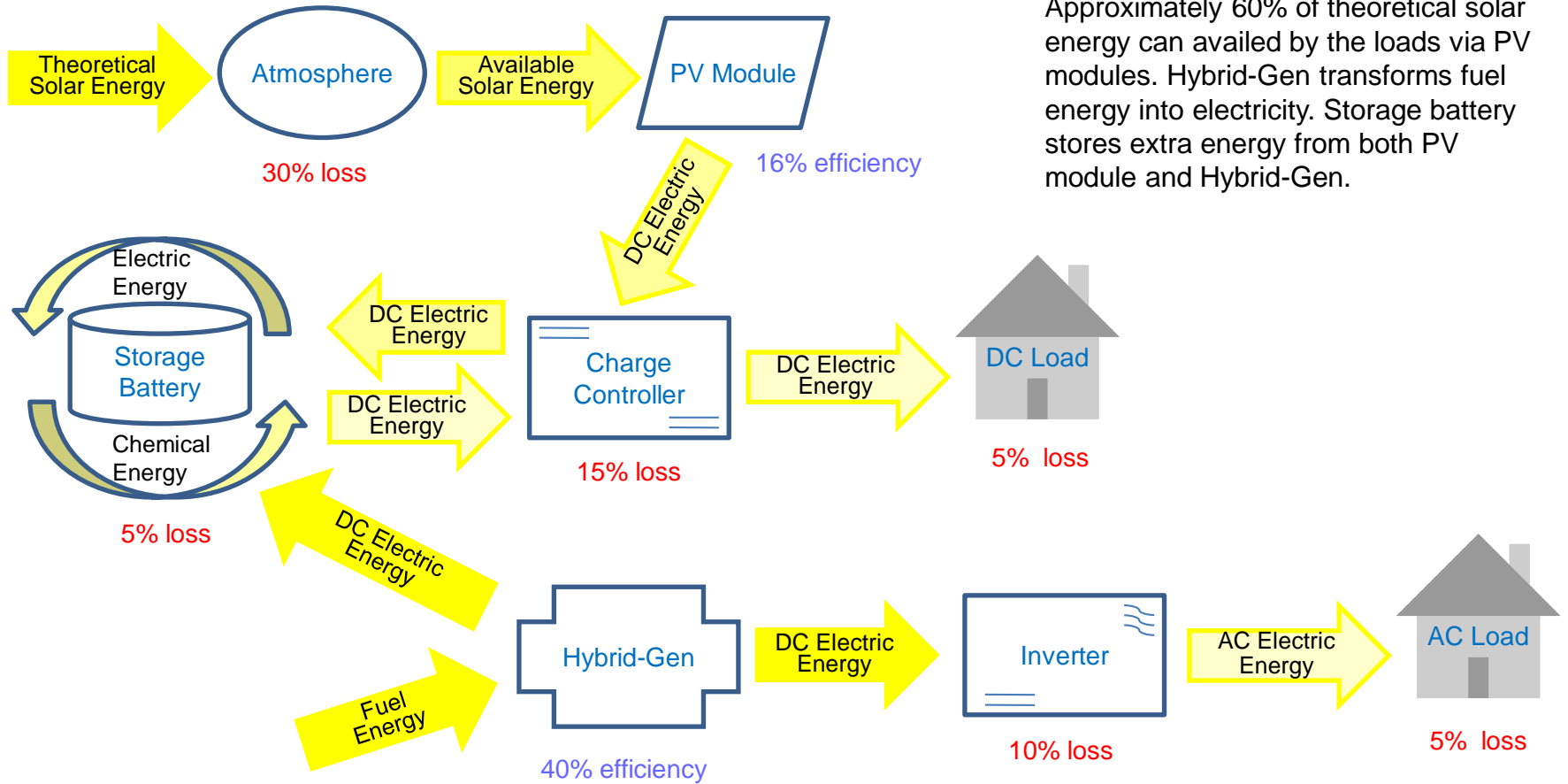


'JUST-IN-TIME' ENERGY PRODUCTION = INCREASED EFFICIENCY

‘JUST-IN-TIME’ ENERGY PRODUCTION CONCEPT

- ✓ Smart Power Management System (PMS) detect load profile
- ✓ Energy storage + inverter system creates the grid and “follows” the load
- ✓ Allow multiple renewable energy input
- ✓ Store excess energy
- ✓ Conventional generation covers base load and operate optimally

Energy Transformation Flow Chart

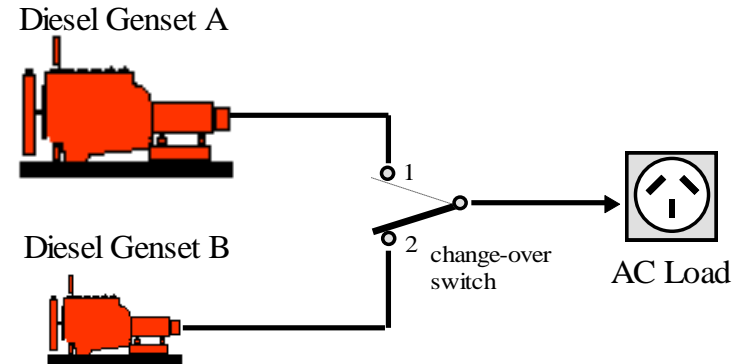


Approximately 60% of theoretical solar energy can be available by the loads via PV modules. Hybrid-Gen transforms fuel energy into electricity. Storage battery stores extra energy from both PV module and Hybrid-Gen.

Proprietary Hybrid Variable Speed Generator is an innovative leap

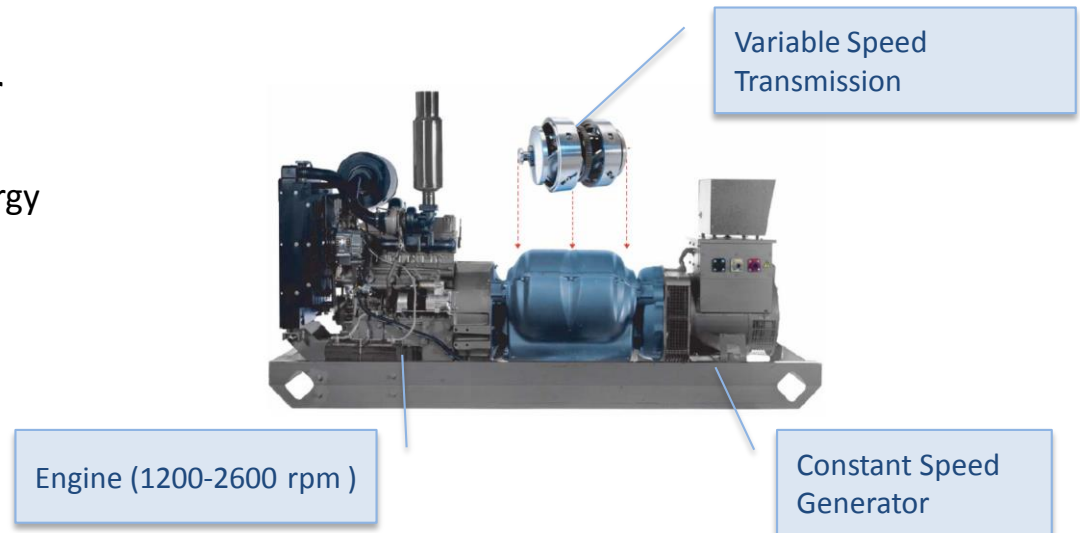
Others: Dual Diesel Generator system

- When the load is light, the smaller generator is used; as the load increased, the manual switch is transferred to the larger generator. This approach results in some fuel savings, however managing this dual system would be time consuming and impractical.

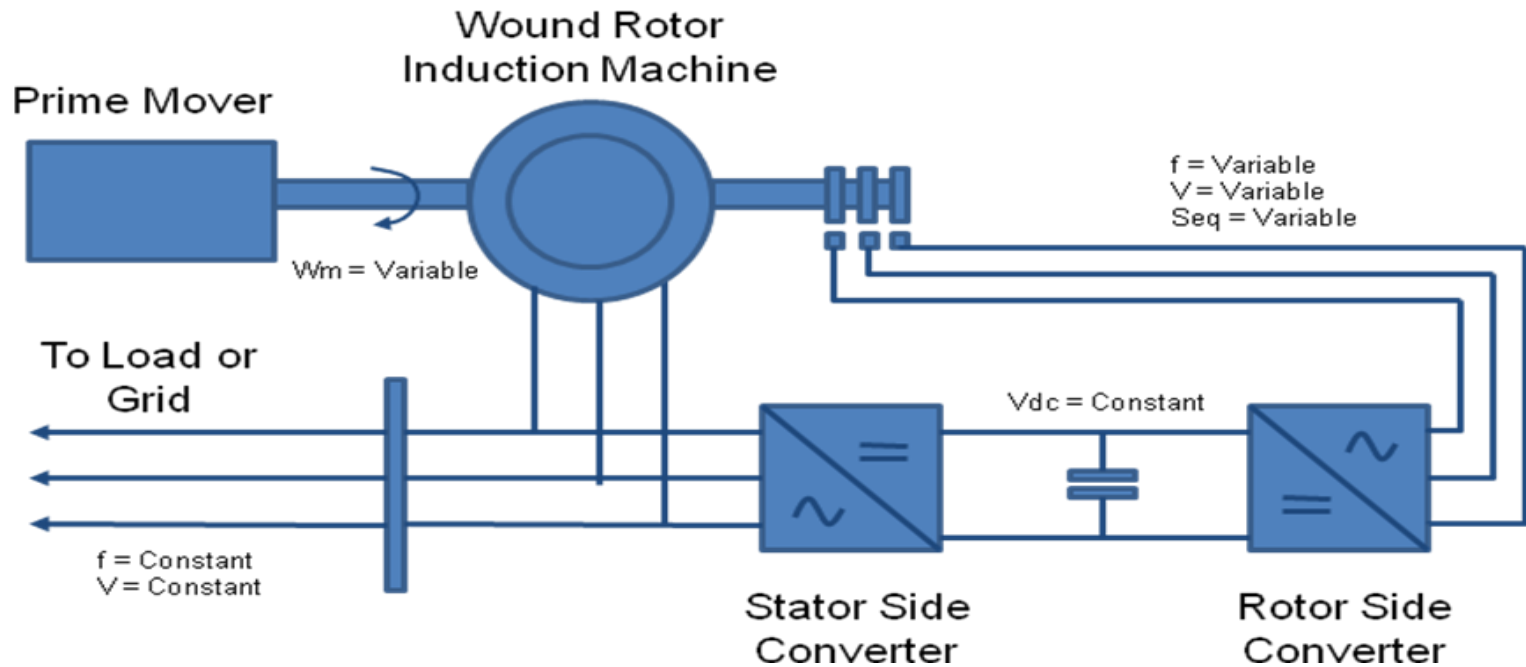


DLRE: Hybrid-Gen Variable Speed Generator

- Making use of renewable energy
- Allows high penetration of renewable energy sources
- Diesel Generator can compensate the fluctuation of renewable energy sources
- Energy storage in batteries with high conversion efficiency possible



Hybrid Variable Speed Generator



Constant Voltage & Frequency

HybridGen™ is based on a Doubly Fed Induction Generator (DFIG) system which uses a wound rotor induction machine with the rotor's voltage controlled by two converters in a back to back configuration. The stator and rotor side converters work together to create a frequency changing circuit. On the grid side the frequency is fixed normally at 50Hz, and on the rotor side the frequency will vary depending on the rotor speed.

Hybrid Variable Speed Generator

BENEFITS

Variable Speed

- Smaller engine displacement
- Lower fuel consumption
- Automatic & prompt speed shift

Battery Management

- Optimum energy use
- Smaller battery bank & longer life
- Automatic start & stop

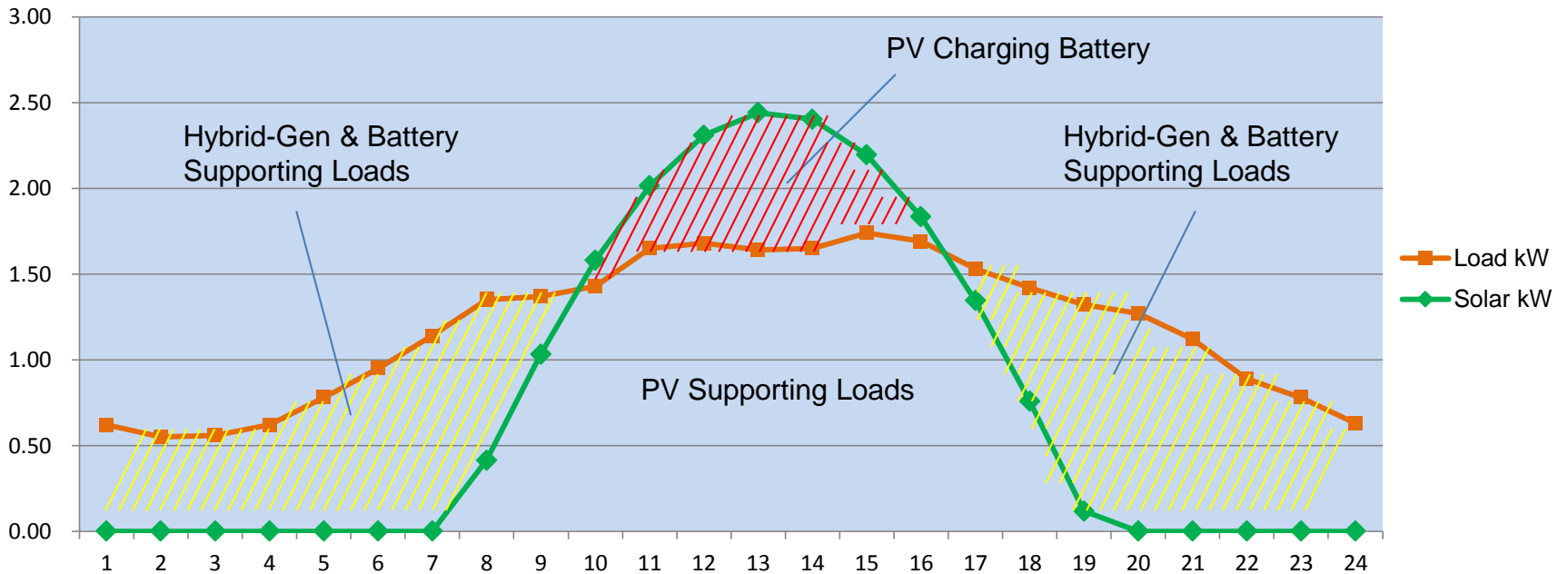


Hybrid Variable Speed Generator

Output (kW)	Fuel Eff. Optimum Speed (L/kWh)	Fuel Eff. Rated Speed (L/kWh)	Fuel Saving (%)
1.0	0.649	0.914	40.8
2.0	0.377	0.541	43.5
3.0	0.331	0.412	24.5
4.0	0.337	0.368	9.2
5.0	0.293	0.339	15.7
6.0	0.275	0.320	16.4
7.0	0.279	0.296	6.1
8.0	0.294	0.297	1.0

Higher Efficiency = Fuel Saving

DLRE Technologies allow for Energy Equilibrium



PV & Load Curves August (worst month)

PULAU UBIN MICRO-GRID TEST-BED

- 240VAC underground cabling system
- Approximately 100kWp Solar PV
- 1MWh energy storage
- 6 x 40kVA hybrid variable-speed generators distributed (3x2)
- Intelligent control & remote monitoring system



Electricity Supply Situation on Pulau Ubin



10 October 2013:
Pulau Ubin became more tranquil, as dozens of the "privately owned diesel generators" were no longer required for operation.

Pulau Ubin Micro Grid Test Bed Project is an effort to provide power to the residents of Ubin, with sustainable and renewable energy as a part of the solution.

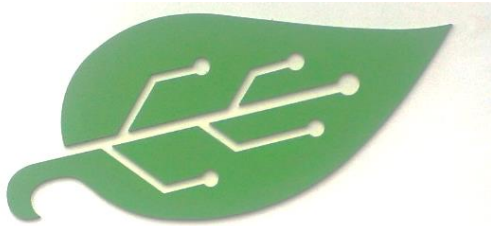


Solar energy produced during the day are charged into the battery bank.



Hours of electricity usage was supported from the battery bank during night time, for residents to enjoy the quietness without darkness.

The solar energy generated is also used to maintain the necessary connections for the residents and visitors, as the Telecommunication Towers and phone lines are supported by the Micro Grid.



Pulau Ubin

micro-grid test-bed

The Police Station, the street lights at the ferry pier, the water pumped from the wells for the washrooms, are all powered by the Micro Grid now.





Daily Life Renewable Energy as the operator brought the latest power generation and Micro Grid Technology to light up the island with solar panels and extra fuel efficient variable speed generators.

ENERGY MARKETS AWAITING FOR DEVELOPMENT



Illustrating areas with access to electricity at night

	Population without electricity (million)	Electrification rate (%)	Urban electrification rate (%)	Rural electrification rate (%)
Africa	587	41.8	68.8	25.0
North Africa	2	99.0	99.6	98.4
Sub-Saharan Africa	585	30.5	59.9	14.2
Developing Asia	675	81.0	94.0	73.2
China & East Asia	182	90.8	96.4	86.4
South Asia	493	68.5	89.5	59.9
Latin America	31	93.2	98.8	73.6
Middle East	21	89.0	98.5	71.8
Developing Countries	1,314	74.7	90.6	63.2

Source: WEO 2011, IEA

DEVELOPING COUNTRIES

- ✓ Mini grid environment running exclusively on diesel generators
- ✓ Powering off grid areas and allowing integration into national grid over time
- ✓ Untapped market in Asia and Africa

BARRIERS

- ❖ Access to market: regulatory and cultural
- ❖ Access to finance: development and concessional financing ?
- ❖ Ability to pay: economic activity ?
- ❖ Country risk: political and currency

Thank you for Listening!



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