INTERNATIONAL RENEWABLE ENERGY AGENCY

Renewable Energy Technology for Rural and Remote/Island Areas

Global Perspective

Bangkok, 21 June 2016
Global Trend
Renewable Energy Development
2015: a record year for renewables

- 156 GW of renewable energy capacity added, including 51 GW PV, 64 GW wind power, representing more than half of the global added power generation capacity.

- Investment into renewables, excluding large hydro, has risen from USD 55 billion dollars in 2004 to more than USD 285 billion in 2015, at an annual growth of over 16%.

- Solar PV USD 29/MWh in Dubai; wind USD 40/MWh in Egypt.

- The wide adoption of the Paris Agreement.

- Emissions from the energy sector trends to flatten out largely attributable to the increased use of renewables.
Renewables investments have overtaken non-renewables

Sixty percent of new capacity in the last two years

2015 record year in installations of solar PV (51 GW) and wind (64 GW)
Solar PV module prices have dropped by more than three-quarters since 2010, while global wind turbine prices have declined by around 30% since the same year.
What does it mean to rural and remote areas?
The Challenge

- By 2030, despite of 1.7 billion of new electricity users, still about 1 billion people without access to electricity
- By 2050, energy demand is set to more than double
The Main Grids

Power grid extension sometimes means differently to different people
Renewable Energy Solutions

Off-grid renewable energy systems now represent the most cost-effective solution to expand electricity access in many rural areas.

Energy supply by renewable resources providing more than just renewable energy sources.
Pacific Leaders Energy Summit, Tonga 2013:
- Need for co-ordination between donor offers & national needs
- Need to work fast & maintain momentum
- Need to work holistically & consider interlinks with other sectors (tourism, water, etc.)
Solar PV electricity matching demand well in some cases

Pacific load curves *Day peak fits well with PV, yet grid integration is a growing challenge*

Source: IRENA, 2012
Grid integration studies

Facilitate coordination between long-term, policy-driven RE targets and their actual deployment in the grid

Assessment of reliability and security of the system with planned penetration levels of VRE through statistical analysis and electricity grid modelling & simulation

Identification of technical solutions to maintain reliable grid operation

Provision of technical assistance and online access to simulation software DIgSILENT PowerFactory to do grid studies with local human capacities
- Detailed electrical grid modelling
- Assessment of reliability and security of the system with planned penetration levels of RE
- Identification of technical solutions to maintain reliable grid operation
- IRENA’s support provides technical assistance and simulation software to do grid studies with local human capacities
Grid integration studies

Cooperation with decision makers, network operators and technical experts at a global level supporting exchange of experiences on grid operation & expansion

Antigua & Barbuda (study), Barbados (review of studies) CARICOM Framework for grid integration studies (ongoing with CWR)

Seychelles (review of studies)

Samoa, Cook Islands, Palau (studies), Kiribati (study ongoing with PPA), Fiji & Vanuatu (studies starting), Regional expert meetings

DIgSILENT, TU Darmstadt, TRACTABEL-ENGIE (simulation software and methodological guides)
Case study Antigua - background

Antigua

- Peak load around 50 MW
- Annual electricity consumption around 350 GWha
- Over 100 MW of installed diesel capacity
- 160 GWha purchased under PPA
- Assessment impact of 9 MW of PV and 18 MW of wind (government projects)
- Identification of maximum capacity of the network to host PV systems
Study case Antigua – findings

• Performance criteria fulfilled without major updates in the grid
• Changes in reserve allocation practices required
• Utility not willing to allocate contingency reserves
• Stability of the system relays on load shedding scheme
• Grid support functions provided by utility scale PV and wind are crucial: Reactive power control capability, FRT, Over frequency response
• Frequency range of operation of utility scale PV and wind must be the same from protection settings of diesel generators
• Automatic generation control recommended
Lessons learned in Island cases

- IRENA’s approach has evolved from “grid stability studies” to grid operation planning
- The deployment of high shares of variable renewables is a long journey
- Each island is a unique case. Particularities define approach required for assessments
- Grid integration assessments are a continuous / iterative process
- The biggest challenges are data collection and communication of messages
This report evaluates technology innovations renewable energy based mini-grids:
- Autonomous basic and full service
- Interconnected for community and industrial applications

Mini-grid design
Resource and load planning

Electrochemical
Mechanical
Thermal
Chemical
Electrical

Photovoltaic
Wind
Hydro
Biomass
Technologies

Control, manage and measure

Plan and design

Store

Generate

Convert

Consume

Controls
Data communication and standards
Metering and monitoring
Interoperability and interconnection

DC appliances and DC grids
Demand-side management
Energy efficiency

Grid-following inverters
Grid-forming inverters
Dual mode inverter
DC-to-DC conversion
Innovation & technology outlook: Technology Research Opportunities

Control, Manage and Measure

Grid-forming converters

<table>
<thead>
<tr>
<th>Indicators</th>
<th>2015</th>
<th>2025</th>
<th>2035</th>
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<tbody>
<tr>
<td>Cost (USD/kVA)</td>
<td>500 – 1200</td>
<td>400– 1000</td>
<td>300 – 800</td>
</tr>
<tr>
<td>Efficiency -DC to AC (%)</td>
<td>85 – 90%</td>
<td>87 – 93%</td>
<td>90 - 95%</td>
</tr>
<tr>
<td>Efficiency -AC to DC (%)</td>
<td>90 – 95%</td>
<td>92 - 97%</td>
<td>95 - 98%</td>
</tr>
<tr>
<td>Lifetime (years)</td>
<td>5 - 10</td>
<td>7-12</td>
<td>10-15</td>
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Grid-following converters

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<th>2015</th>
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<tr>
<td>Cost (USD/kVA)</td>
<td>110 - 170</td>
<td>100-150</td>
<td>100-150</td>
</tr>
<tr>
<td>Efficiency -DC to AC (%)</td>
<td>95 - 98%</td>
<td>95 - 98%</td>
<td>95 - 98%</td>
</tr>
<tr>
<td>Efficiency -AC to DC (%)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Lifetime (years)</td>
<td>5 - 10</td>
<td>7-12</td>
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Dual-mode converters

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<th>2035</th>
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<tr>
<td>Cost (USD/kVA)</td>
<td>650 – 2500</td>
<td>520 – 2000</td>
<td>450 – 1600</td>
</tr>
<tr>
<td>Efficiency -DC to AC (%)</td>
<td>93% - 96%</td>
<td>94 – 97%</td>
<td>95 - 98%</td>
</tr>
<tr>
<td>Efficiency -AC to DC (%)</td>
<td>87 - 92%</td>
<td>91 – 5%</td>
<td>95 - 98%</td>
</tr>
<tr>
<td>Lifetime (years)</td>
<td>5-10</td>
<td>7-12</td>
<td>10-15</td>
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# Innovation & technology outlook: REBMG

## Innovation Prospects

### The Renewable Energy Based Mini-grid of the Future

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<tr>
<td><strong>Ease of deployment</strong></td>
<td>Custom engineering based on local needs and resources</td>
<td>Planning tools with increasingly modular and scalable technologies</td>
<td>There are standard off-the-shelf products available and low-cost robust planning tools for easy deployment of REBMGs</td>
</tr>
<tr>
<td><strong>RETs penetration</strong></td>
<td>Low-penetration RETs considered in autonomous mini-grids</td>
<td>Autonomous and more economical mini-grids with low cost storage, generation and intelligent controls</td>
<td>Interconnected mini-grids considering higher penetrations of RET for cost-effective resilience</td>
</tr>
<tr>
<td><strong>Commercialisation</strong></td>
<td>Mostly pilots, some commercial autonomous REBMGs for basic service</td>
<td>Commercial autonomous REBMGs for basic service. Some commercial autonomous REBMGs for full service</td>
<td>Commercial autonomous REBMGs for basic and full service. Some commercial interconnected REBMGs for community and industrial applications</td>
</tr>
</tbody>
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The role of policy makers: Economic, educational, regulatory and market policies

The role of private sector investors:

- Undertake fundamental research
- Implement pilot projects
- Deploy REBMNGs
- Transfer technology
- Develop standards and build relationships
ProSPER: Promoting a Sustainable PV Market in the ECOWAS Region

Objective:
Development of a sustainable market for off-grid PV applications by:

- strengthening and developing local capacities of policymakers, regulators and utilities, financial institutions and renewable energy entrepreneurs.

ECOWAS Renewable Energy Entrepreneurship Support Facility

Objectives:
Assist entrepreneurs in specific requests for improving their business operations.
Provide mentorship and technical support to existing entrepreneurs.
Provide advisory services upon request.
Refine entrepreneurs’ Project proposals to bankable levels.

Subject to External Funding:
Established fund to support entrepreneurs in obtaining seed funding and testing the viability of their ideas.
Increased demonstration of pilot projects.
Certification project for solar PV installers in ECOWAS

- **International Certification Accreditation** (e.g. ANSI, ISO/IEC 17024)
  - Verifies that certification providers adhere to international standards

- **Regional Certification Provider** (e.g. NABCEP)
  - Develops technical guidelines (JTA) for renewable energy and designs exams

- **Trained and Certified Technicians**

- **National or Regional Training Accreditation** (e.g. IREC, with IREC Standard 01023)
  - Accredits training programmes, academic institutions under international standards

- **National or Regional Education Providers** (e.g. local universities, technical colleges, vocational training centres)
  - Prepare curricula and training course content based on JTA

- **International or Regional Certification**

- **IREC: Inter-State Renewable Energy Council**
- **NABCEP: North American Board of Certified Energy Practitioners**
- **JTA: Job Task Analysis** (Technical guidelines, competency standards)
1. **Moving away from a project-by-project approach** towards a market-based approach where scale up in off-grid RE can occur sufficiently enough to meet 2030 targets.

2. **Ensuring sustainability in energy access efforts** wherein all elements of the energy service delivery model contribute to reliability and cost-effectiveness.

3. **Leveraging local enterprises and capacities** to expand electricity access in rural areas, rapidly and sustainably, and to maximise value creation.
Objective

- Identify key barriers and drivers for stand-alone and mini-grid RE system deployment
- Platform to share experiences, lessons learned and best practices

IOREC 2012 : Accra, Ghana

IOREC 2014 : Manila, Philippines

Conference outcome papers available at: www.iorec.org
SAVE-THE-DATE

3rd International Off-grid Renewable Energy Conference and Exhibition (IOREC)

30 Sept – 1 Oct 2016; Nairobi, Kenya

More information and registration soon on: www.iorec.org
Thank You!