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Renewable energy mini-grids to expand electricity access

National Study Day on Mini Grids for Urban, Rural and Industrial Development

Engineering Faculty University of Rome “Sapienza”

21 June 2018

Off-grid renewable energy:
Key to universal access to electricity

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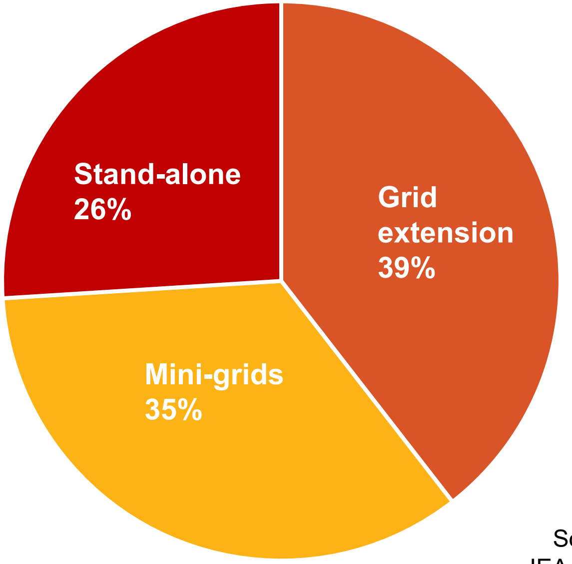
About 60% of additional generation needed to achieve universal access is estimated to come from off-grid solutions (stand-alone and mini-grids)

Contribution of stand-alone systems, mini-grids and grid extension towards universal access

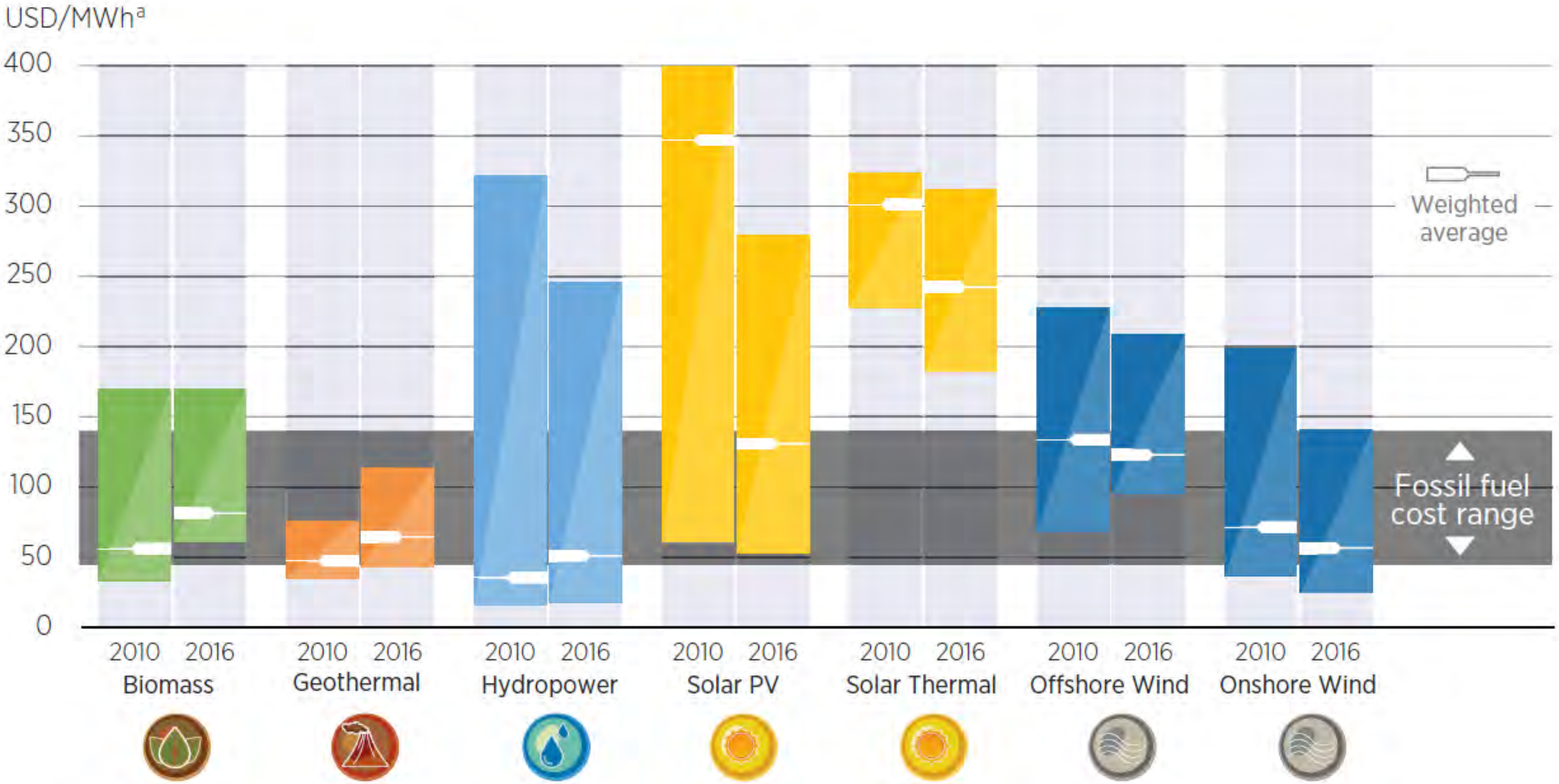


Source: based on IEA (2017) and IRENA

Renewable energy will play a crucial role

RE Costs - Trends

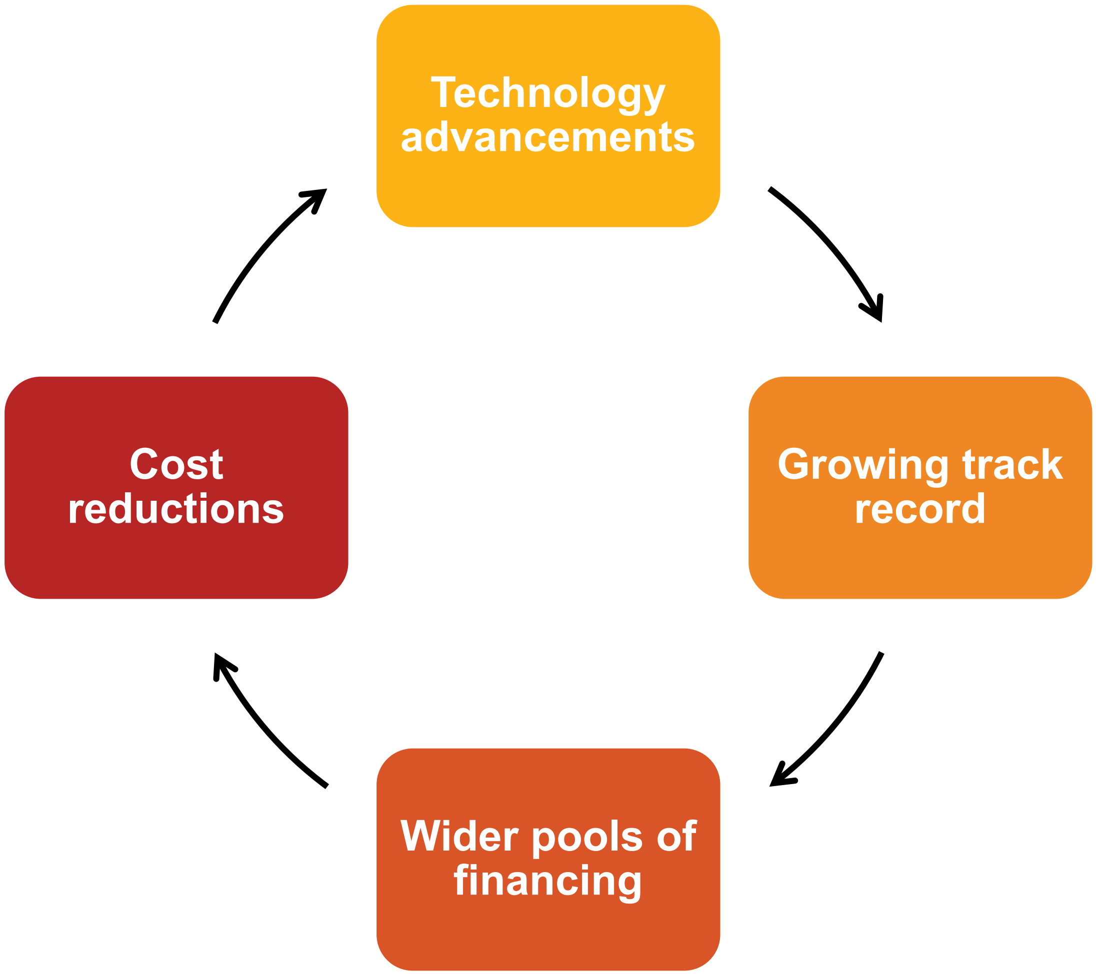
Levelised costs of electricity for utility scale power (ranges and averages), 2010 and 2016



Note: a) MWh: megawatt-hour
b) All costs are in 2016 USD. Weighted Average Cost of Capital is 7.5% for OECD and China and 10% for Rest of World

costing.irena.org

Renewable energy mini-grids



How do we accelerate the pace of renewable energy mini-grid deployment?

Scaling-up off-grid renewable energy deployment : IOREC Platform

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IOREC
International Off-Grid Renewable Energy Conference & Exhibition

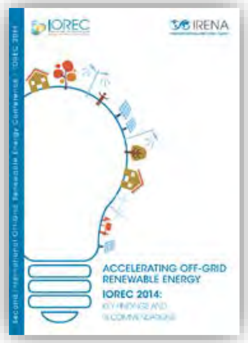
IOREC 2018:
31 October – 1 November 2018
Singapore

Objectives

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

IOREC 2016 : Kenya

IOREC 2014 : Philippines



IOREC 2012 : Ghana

www.iorec.org

Key Elements of an Enabling Environment

Crucial importance of:

- **Capacity building**
- **Private sector involvement**

Policies and Regulations for Private Sector Renewable Energy Mini-grids

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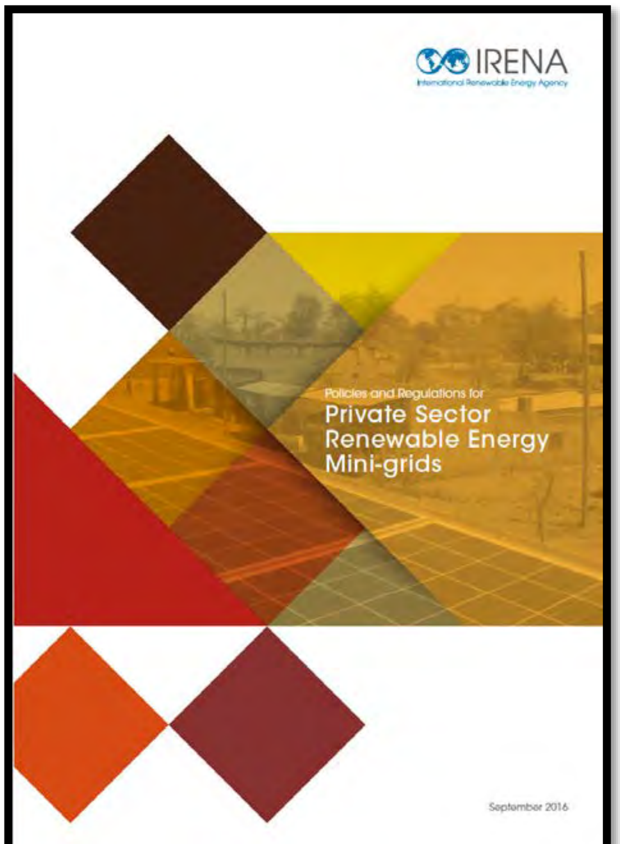

Download at
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Technology innovation is key

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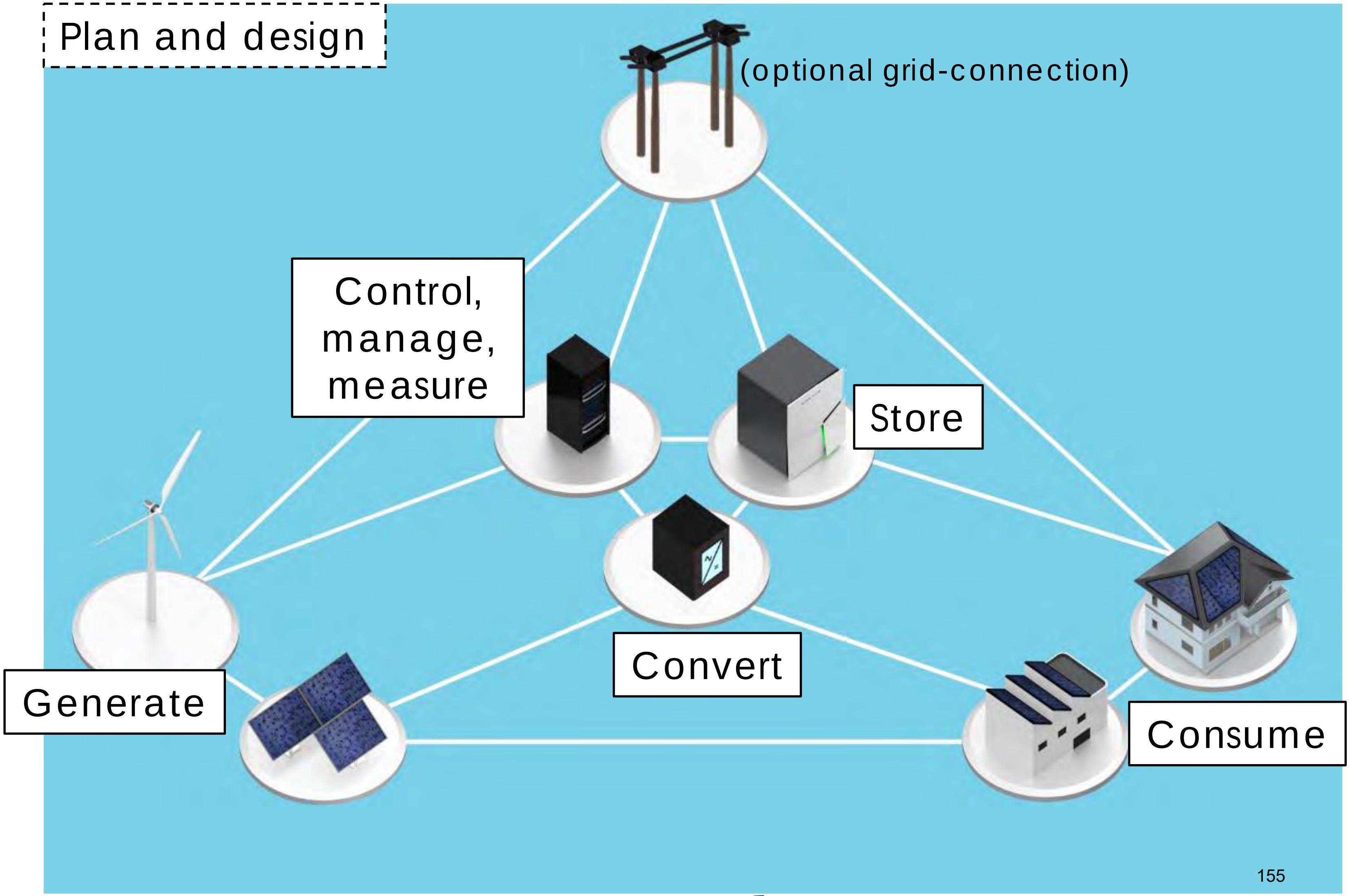

Functionalities

Opportunities for innovation

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Mini-grid Innovation & Technology Outlook *(www.irena.org)*

		Impact			
PLAN AND DESIGN		**Cost**	**Reliability**	**Ease**	**Environmental**
1	Standardised planning and design	****	**	****	**
CONTROL, MANAGE, MEASURE (CMM)					
1	More intelligent controls	***	****	****	**
2	Improved communications and standards	**	****	****	*
3	Improved metering and monitoring	**	***	****	***
4	Simplify connecting equipment together	**	*	****	*
STORE					
1	Use less expensive, more abundant and less resource-intensive materials	****	**	*	***
2	More robust, lower-maintenance technologies to reduce life-cycle costs for storage	***	****	***	**
3	Improvements in long-term storage capability	**	**	**	****
4	Improvements in high power output capability	**	***	**	***
CONVERT					
1	Lower capital costs of converters	****	*	**	*
2	Combine diverse function into inverters	**	**	****	*
3	Improve efficiency, particularly at partial load	**	**	*	***
4	More converter options for diverse renewable mini-grid markets	**	**	****	*
CONSUME					
1	Increased commercial availability of efficient end-uses	****	*	**	****
2	Better user tools for adapting consumption to energy supply (DSM)	****	**	***	****

SIDS Lighthouses initiative

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- **Partnership launched between Small Island Developing States (SIDS), IRENA and other development partners**

- **Strategic objectives:**
  - ***Enabling a sustainable energy transformation for people on the front line of climate change on small islands around the world***
  - ***Improving energy security and economic prosperity on SIDS***

- **Main original elements:**
  - ***Focus on renewable energy deployment in the power sector***
  - ***Information exchange between partners***
  - ***Capacity building in SIDS***
  - ***Improving the knowledge base, including about technology options***
  - ***Supporting renewable energy planning***

islands.irena.org

Renewable Energy for Islands

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Compilation of case studies from SIDS and development partners. These demonstrate real-life project viability, highlight innovative solutions and showcase successful partnerships, which together are advancing the deployment of renewable energy in SIDS

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GRID INTEGRATION STUDIES FOR SMALL ISLANDS

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- ✓ Planning tools and analytical assessments help answer the following questions, usually asked by policy makers and utilities:
  - **How much VRE can be integrated without major system upgrades?**
  - **Is it feasible to achieve the target shares of VRE?**
  - **What is required to achieve the target shares of VRE?**
- ✓ Critical importance of the characteristics of the island system and the target share of VRE
  - Target medium to large size islands (MW scale) where integration takes place gradually and multiple stakeholders are involved
- ✓ Penetration level of VRE may be affected
  - System operation
  - Grid capacity
  - Stability

IRENA Project Navigator

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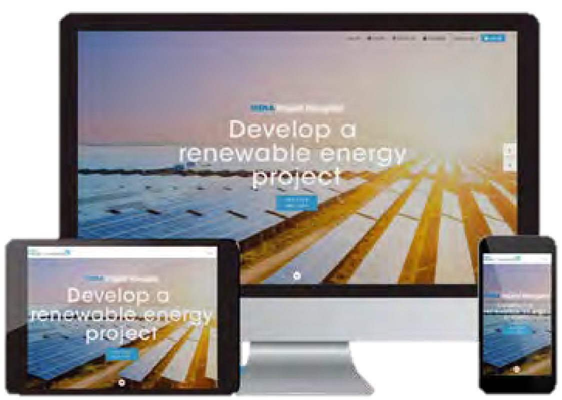
Free online platform providing comprehensive & easily accessible practical information, tools & guidance to assist in the development of bankable RE mini-grid projects

Objectives

- Increase the bankability of projects by:
  - Strengthening the project development base
  - Reducing costs and mitigating risks through proper planning
  - Enhancing the quality of project proposals
  - Facilitating effective implementation

Scope

- All RETs
- Different finance types: grants, loans, equity
- Project sizes: from individual use to utility scale projects
- Global: all geographical regions



www.irena.org/navigator

Capturing the cross-sector development impacts

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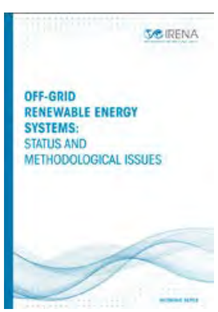
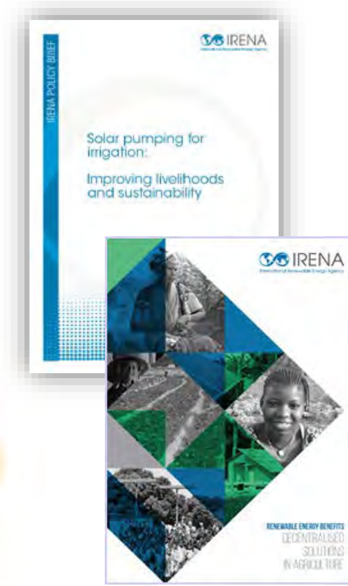
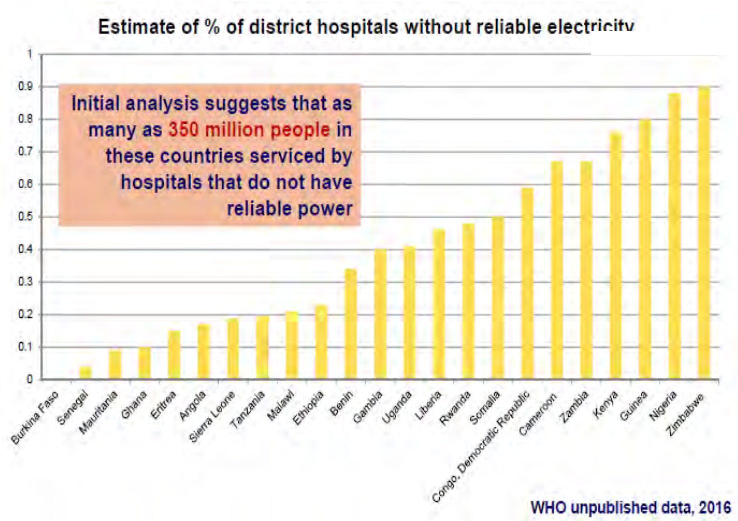
Decentraliced systems to be deployed towards livelihoods and services to maximise sustainability and socio-economic benefits



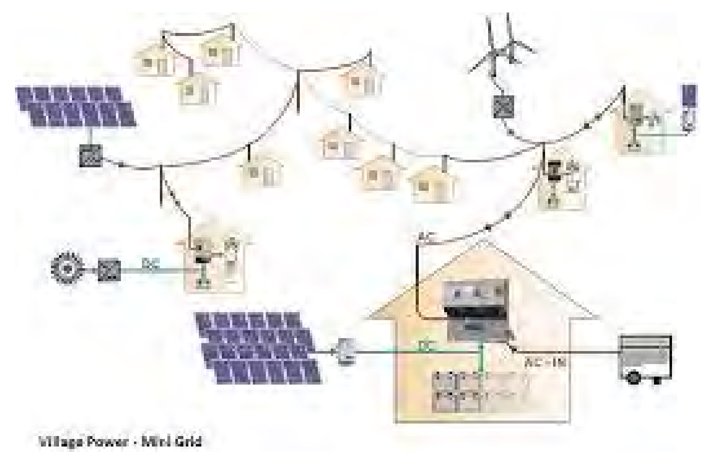


Renewables and Human Development

Health centers



Source: World Health Organization



The water, energy and food *nexus*

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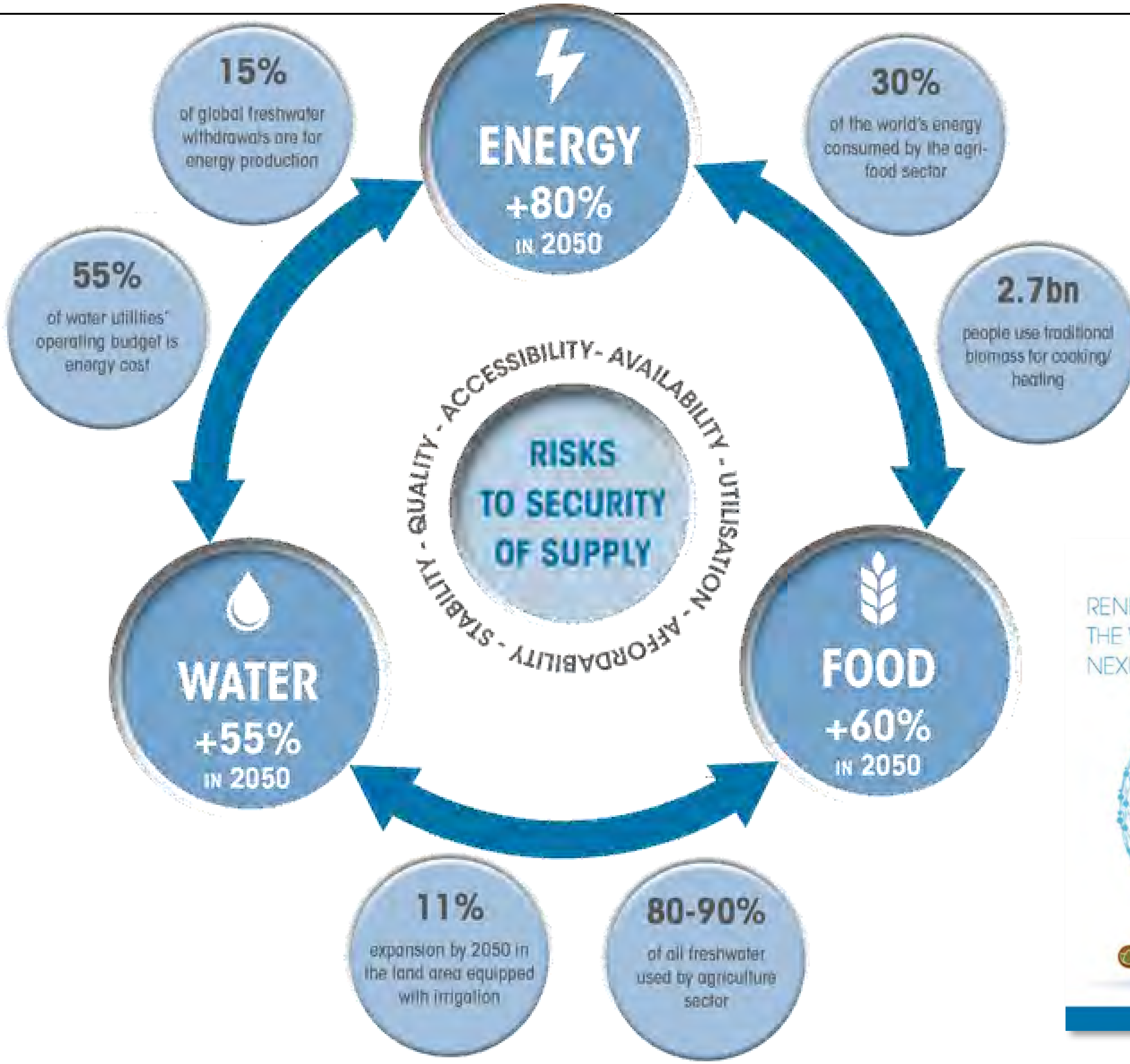

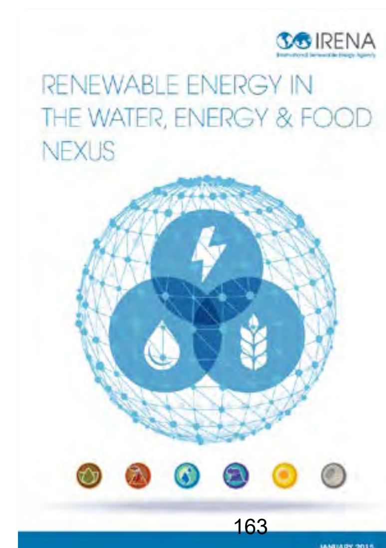

Renewable energy in the energy-food nexus

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Renewable energy opportunities in the food supply chain

ENERGY
FOOD

Energy inputs (traction, electricity, mechanical, heat/cooling)

Primary Production	Post-Harvest and Storage	Transport and Distribution	Processing	Retail, Preparation and Cooking
• Solar, wind-based water pumping • Biofuels for tractors and on-farm machinery • Solar-based desalination, heating and cooling for protected cropping • Biomass residues use for on-site energy generation • Indirect renewable energy inputs for fertilisers	• Solar, geothermal food drying • Solar cooling and refrigeration	• Biofuel use for transportation and distribution • Solar cooling and refrigeration	• Solar, wind, hydro-based milling, threshing • Renewable energy-based electricity and heat applications	• Renewable energy-based water purification • Modern biomass use for cooking applications

Source: IRENA (2015) based on FAO (2011) and Practical Action (2012)

Socio-economic benefits in the agri-food chain

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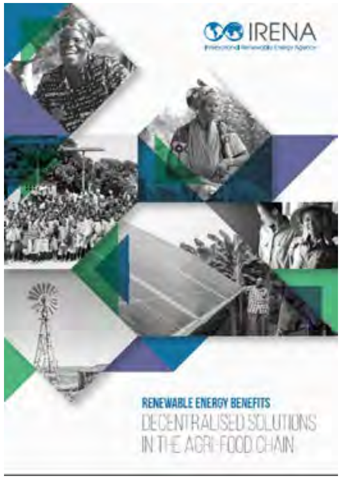
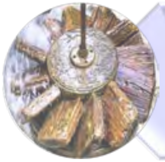
- Socio-economic impacts
  - Economic benefits
  - Health benefits
  - Environmental benefits
  - Well-being benefits




Water pumping for irrigation


Drying produce


Refrigeration


Agro-processing


Cooking and water heating

Economic benefits

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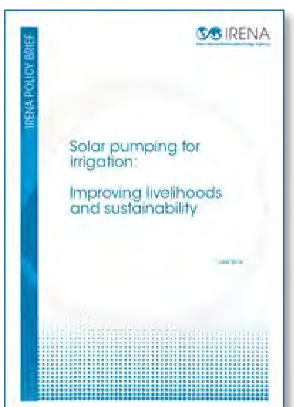
Economic benefits
Health benefits
Socio-economic impacts
Environmental benefits
Wellbeing benefits



Savings on energy spending

- At the national level, the deployment of 4 000 solar pumps in the Indian state of Rajasthan, has enabled the saving of 2.4 million litres of diesel fuel, and, consequently, has led to annual savings in government subsidies on diesel of more than USD 350 000.
- At the farm level, the replacement of two diesel-powered water pumps with solar pumps in salt farms in India resulted in annual savings of USD 1 277, enabling the recovery of the investment in three years.

Job creation

7,572 people employed in operating 8,493 IWMs in Nepal

Biogas programme in Nepal employs total 1,083 FTEs on an annual basis

Income generation

- In Zimbabwe solar pumps increased household incomes by 286% for the very poor, 173% for the poor and 47% for middle-income groups
- A solar dryer in Malawi can dry 90 kg of maize grain per batch and has a payback period of less than one year if surplus grain is dried and sold in the market

Health benefits

Economic benefits

Health benefits

Socio-economic impacts

Environmental benefits

Wellbeing benefits

Prevention of malnutrition and food contamination

- Food losses as high as 40-50% for root crops, fruits and vegetables, 30% for cereals and fish, and 20% for oilseeds
- Polluted water consumption causes 4% of all deaths in rural areas

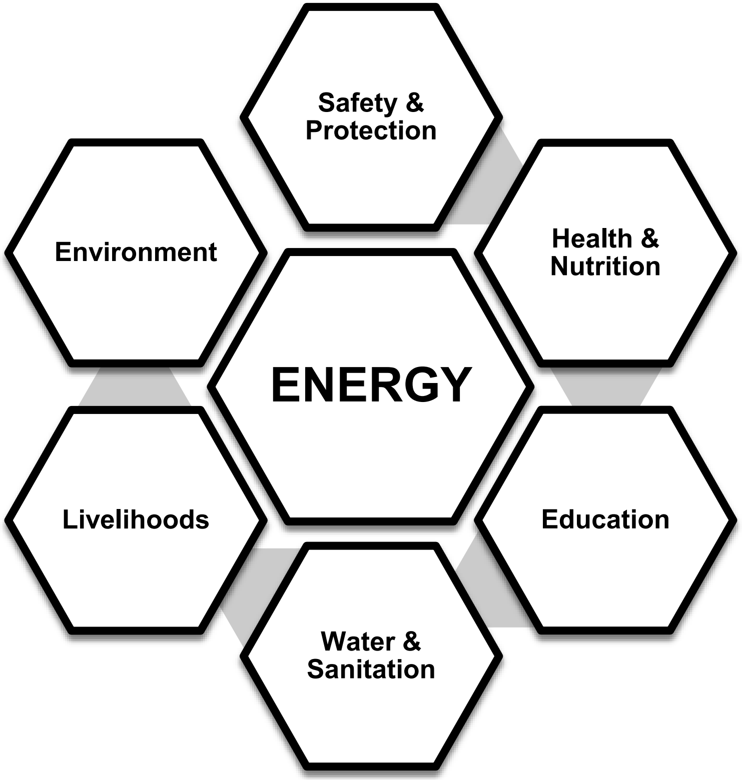
Reduced deforestation and emissions

- Globally, 5 million solar pumps can save 10 billion litres of diesel, and nearly 26 million tonnes of CO_2 (equivalent to annual emission from 5.5 million vehicles)
  - The introduction of biogas digesters in rural Nepal enabled the saving of almost 250 kg of wood per month per household
  - In Sri Lanka, biomass digesters replacing diesel for tea drying in nine tea factories saved the burning of 1.2 million litres of diesel and almost 3 000 tonnes of CO_2 annually

Energy Access in Refugee Settings

"An unprecedented **65.6 million** people around the world have been forced from home. Among them are nearly **22.5 million refugees**, over half of whom are **under the age of 18."**
(UNHCR, Figures at a Glance, 2017)

Energy cuts across several humanitarian relief priorities



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Renewables and Human Development

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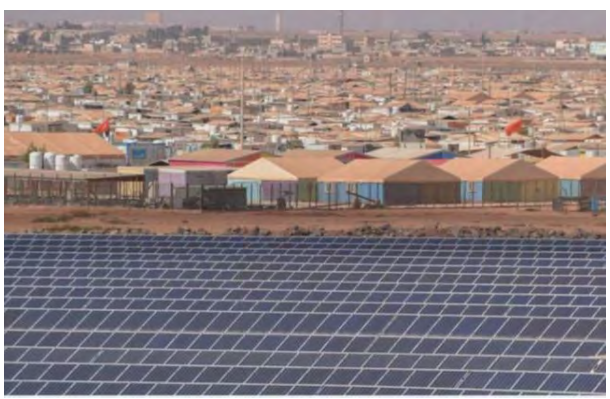
Renewable Energy Opportunities in Refugee Settings

- Provision of electricity through renewable energy mini-grids and standalone systems for lighting and productive uses (only 10% refugees worldwide have reliable access to electricity – UNHCR estimate).
- Reduction in operational costs of refugee protection (USD 60 million/year spent on diesel – UNHCR estimate).
- Provision of water through solar pumping.
- Communal lighting through solar street lights.

Solar mini-grid providing lighting to refugees in Nepal



12.9 MW Solar PV installation at Za'atari refugee camp in Jordan saves UNHCR 500,000 USD per month in energy costs

Solar street light at Azraq refugee camp in Jordan

Solar powered borehole pumps at the Dagahaley refugee camp in Kenya

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Thank you