



**4<sup>TH</sup> INTERNATIONAL OFF-GRID RENEWABLE ENERGY CONFERENCE & EXHIBITION**

# **Innovation and quality infrastructure for off-grid solutions**

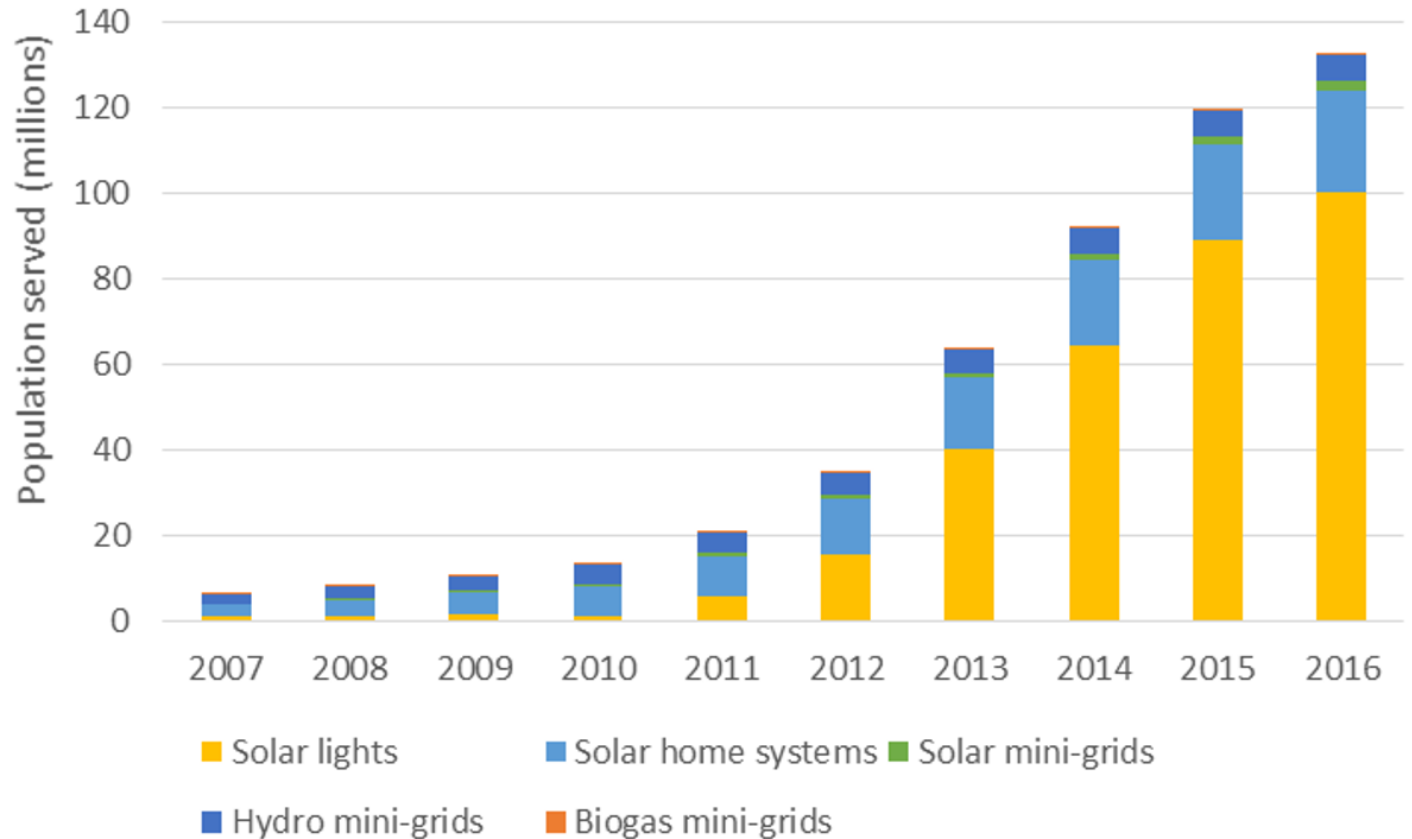
**Roland Roesch, Deputy Director  
IRENA Innovation and Technology Center**



# Renewable solutions for energy access

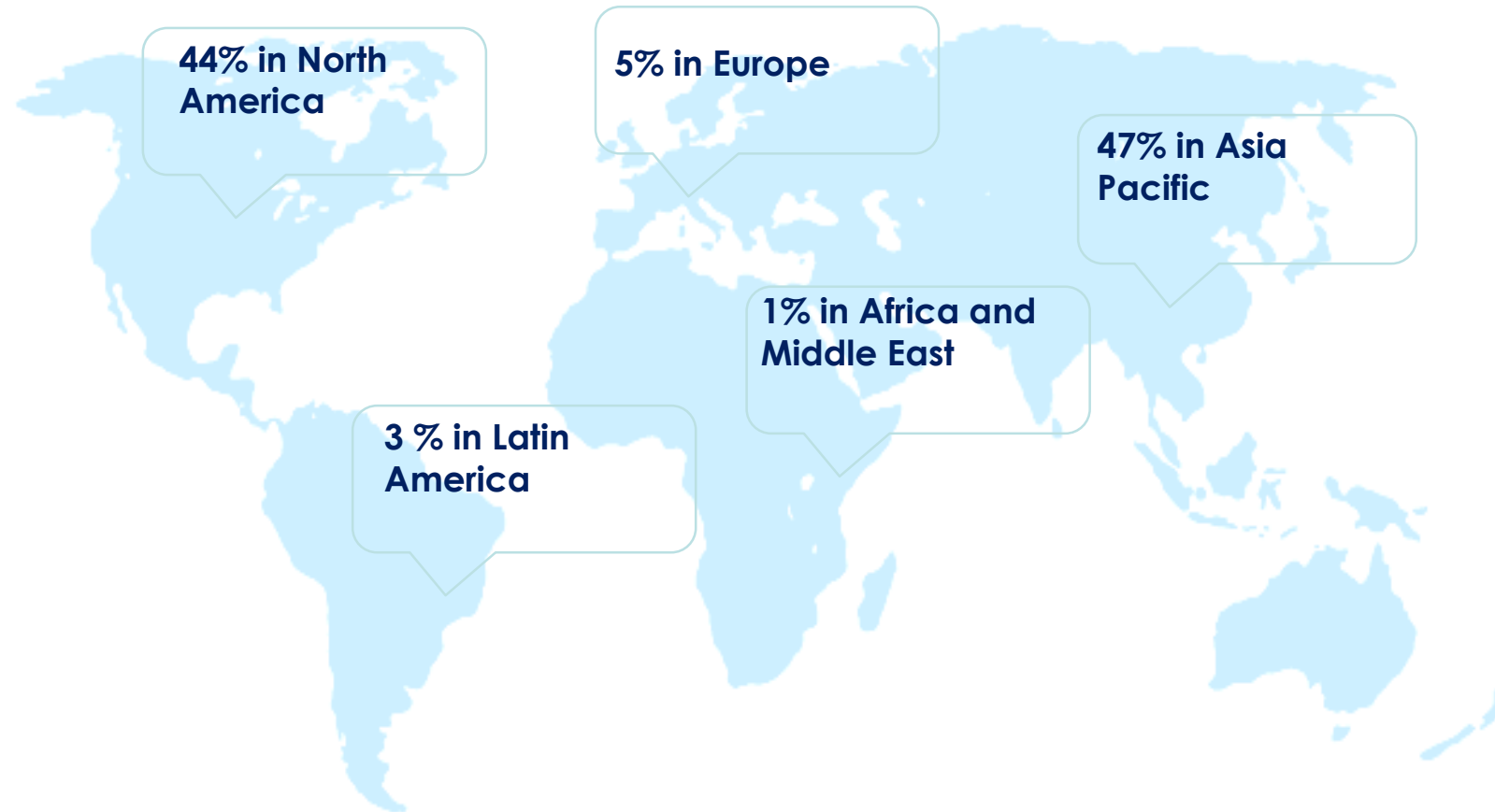


- Some 1.1 billion people without electricity access today
- ~ 130 million served by RE systems:
  - 100 M solar lights
  - 24 M solar home systems
  - **9 M through mini-grids**
- 50 – 250 GW potential to hybridise existing diesel generator capacity, 12 GW on islands
- 1 million telecom towers in South Asia and Sub-Saharan Africa



Source: IRENA (2018) OFF-GRID RENEWABLE ENERGY SOLUTIONS

# Renewable mini-grids market

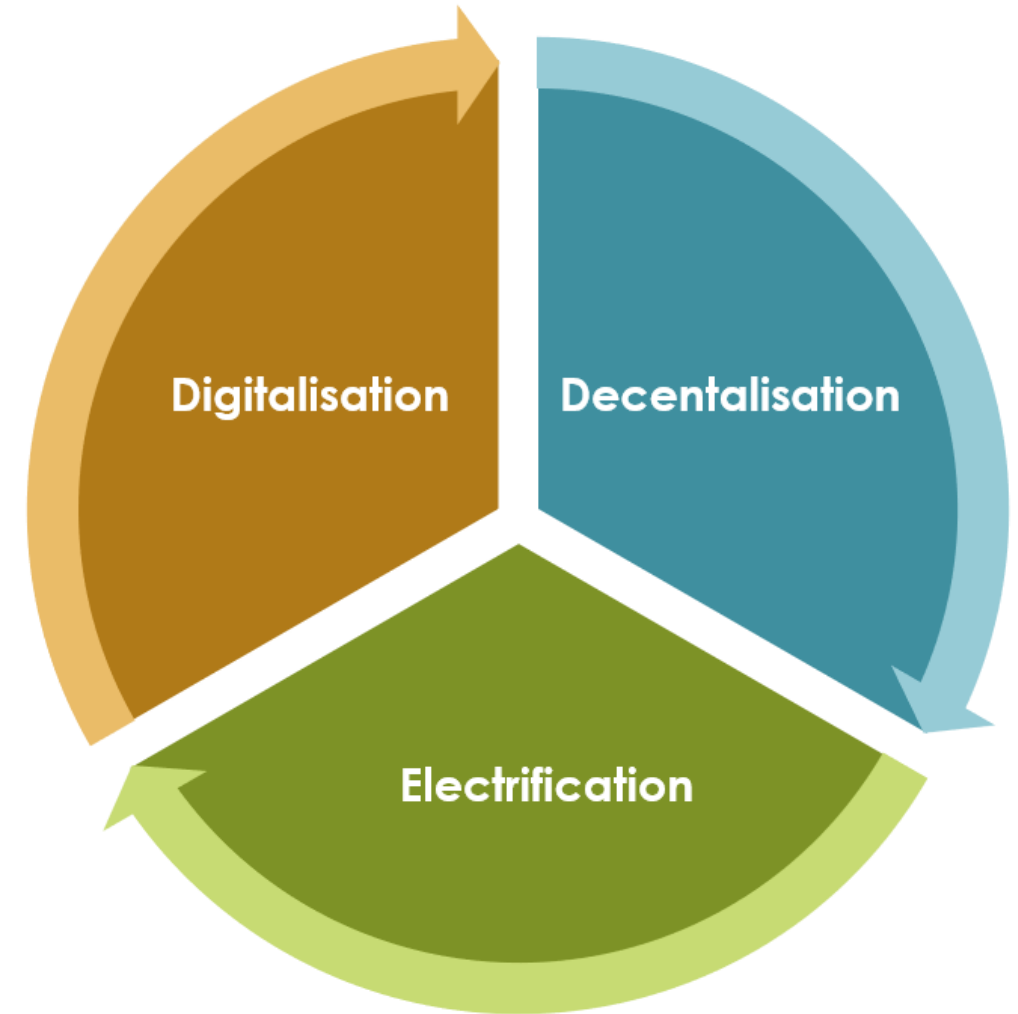


Great untapped potential in Africa and Latin America

# Off-grid innovative solutions propelled by three trends



- **Decentralisation.** Wind and PV is largely centralized today but distributed generation - notably rooftop PV, ~ 1% of all electricity generation today – is growing bringing new flexibility opportunities at demand side
- **Digitalisation.** Key enabler to amplify the energy transformation by managing large amounts of data and optimizing systems with many small generation units
- **Electrification.** It plays in two ways, may decarbonize end-use sectors through renewable electricity and, if done in a smart way, become a flexibility source to integrate more renewables in power systems



# Innovation Outlook: Renewable mini-grids



## TECHNOLOGY DEVELOPMENT

- Autonomous mini-grid systems supplying basic services are widely deployed. Interconnected mini-grids are still emerging
- Deployment concentrated in East Asia and North America. Great potential in Africa and Latin America
- Ground-breaking improvements are under way, particularly in control systems and energy storage – Cost reduction in batteries, artificial intelligence for control systems

## IMPACT OF INNOVATION

- Cost reduction: 60% reduction in the next two decades (LCOE ranging between 19 – 35 USD cents/kWh in 2035)
- Increased share of RE in hybrid systems (from 60% to close to 100% as optimal RE share)
- Mini-grids filling the niche market between SHS and grid extension
- Mini-grids providing resiliency services for main grids
- Technology enabling new business models, e.g. facilitating role of aggregators





## Report: Quality Infrastructure for mini grids

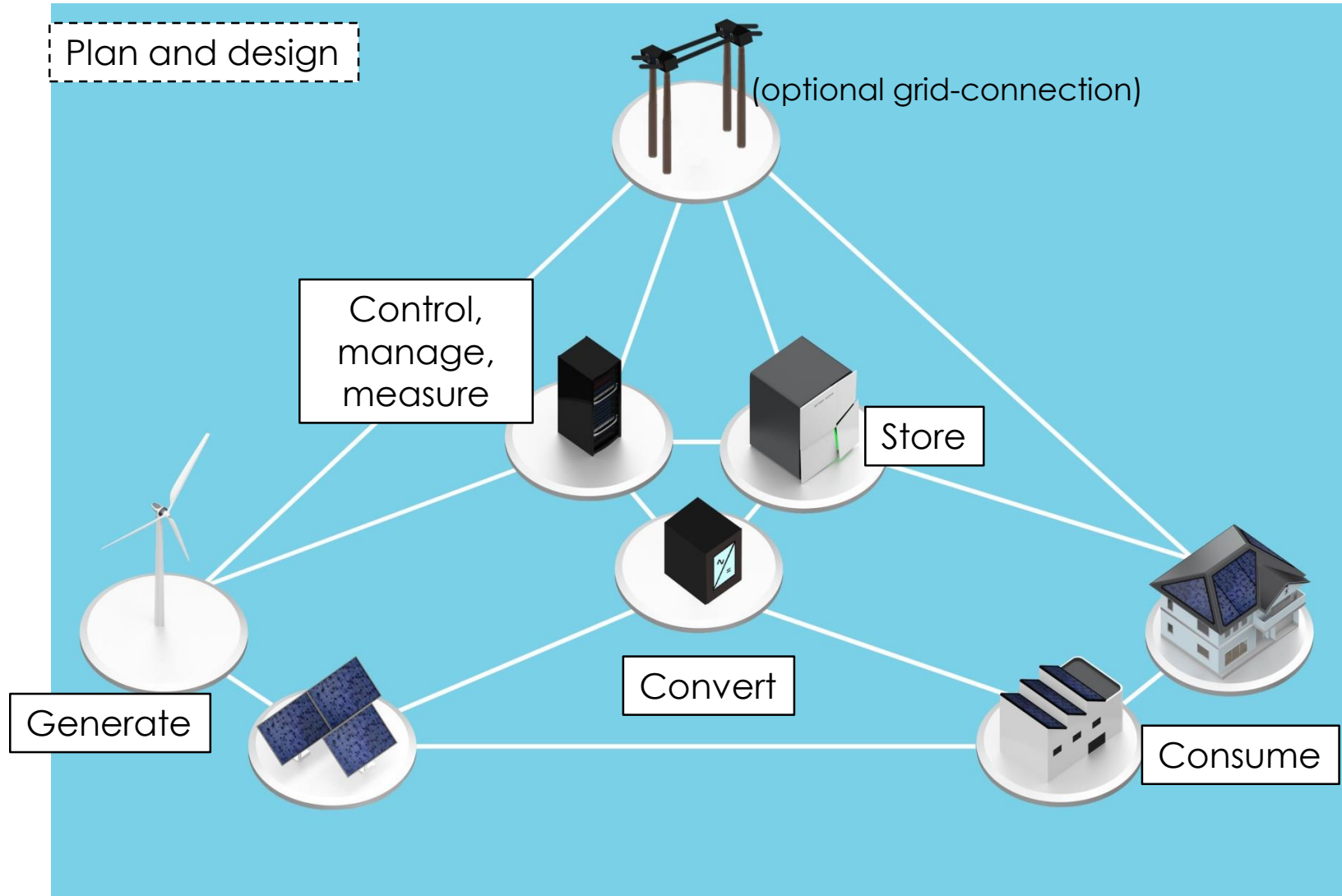
1. Brief on the market status and costs
2. Quality gaps in mini-grids functionalities
3. Costs and benefits of QI deployment
4. Needed QI in the future
5. Strategies to develop QI
6. QI in policy frameworks



Alliance for Rural Electrification  
*Shining a Light for Progress*

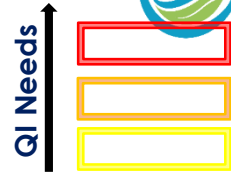


# Mini-grid Functionalities





# Summary of gaps in standards and quality control for future mini-grids



Incorporate **QI and monitoring mechanisms** since the planning and design

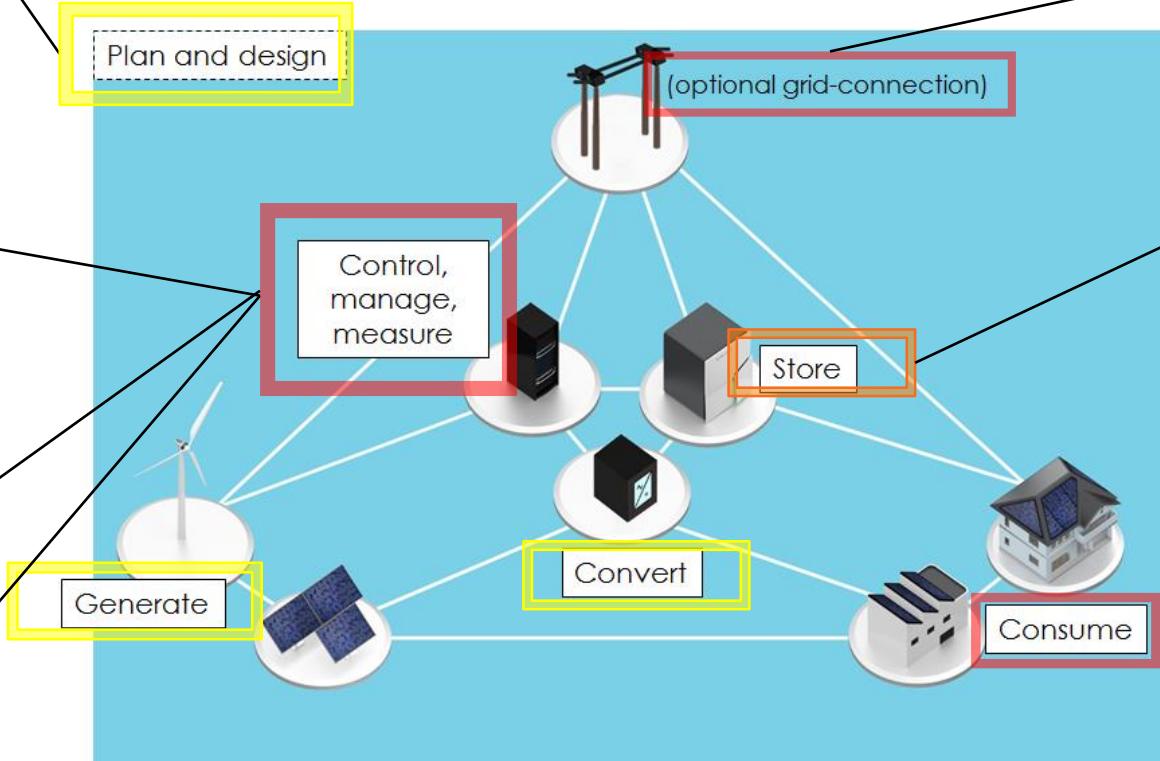
International standards for seamless transition between **grid-connected and islanded operation**  
Clear **interconnection** regulations

Harmonization of **IoT-related standards** (hardware, cloud, security, industry, privacy) preferably at international level (vs today's multiple mostly private/proprietary standards)

Harmonized standards & test procedures of EVs and charging equipment  
Power to X testing

Systemic approach for **cybersecurity**

Need for standards and regulations on **data collection**



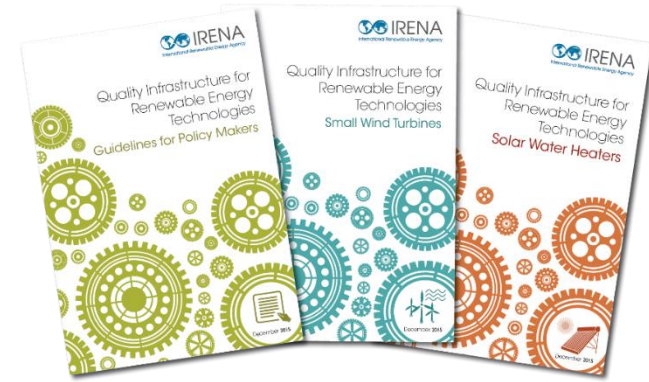
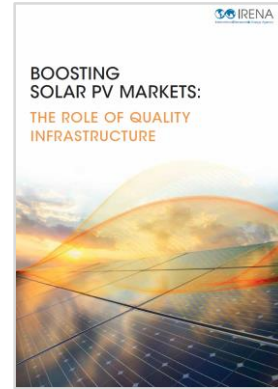
**DC mini-grids:** Adjustment AC standards and DC voltages standardization.  
**Prosumers:** transaction safety, performance and cost reporting standardisation



# IRENA Innovation and quality work



## Innovation Outlooks

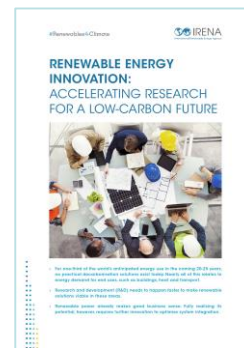


## Quality Infrastructure Series

## Innovation reports



## Innovation Landscape Report for the Power Sector Transformation



## INSPIRE: IRENA's online platform for standards and patents



# Thank you

Download report for free at:  
<http://www.irena.org/publications>



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- **Back up**

# Deployment today

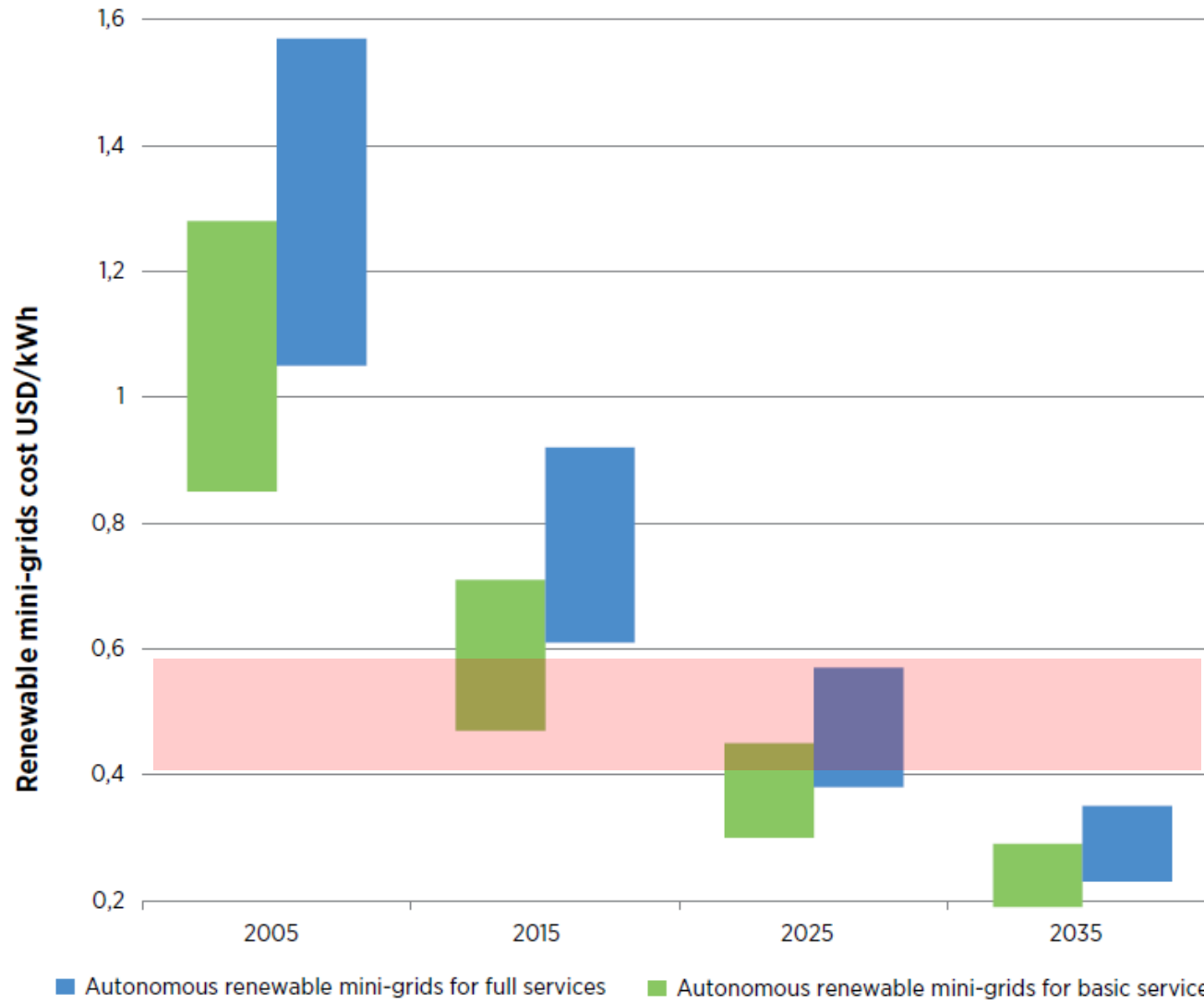


Limited	Pilots	Emerging	Mature
●	●	●	●

Region	Autonomous Basic	Autonomous Full			Interconnected Community	Interconnected Large Industrial
Canada and USA	●	●			●	●
Caribbean, Central America, Mexico	●	●			●	●
South America	●	●			●	●
Europe	●	●	●	●	●	●
North Africa	●	●			●	●
Sub-Saharan Africa	●	●	●		●	●
Central and North Asia	●	●			●	●
East and South Asia	●	●	●	●	●	●
Middle East	●	●			●	●
Oceania	●	●	●		●	●
Antarctica		●				

Off-grid (autonomous) mini-grids more mature than grid connected (interconnected) mini-grids

# Innovation making renewable mini-grids competitive



Unsubsidised cost ranges for renewable mini-grids from 2005 to 2035 for a 100% renewable energy community system



		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)	*****	**	***	*****

# Innovative Low Voltage Direct Current (LVDC) mini-grids

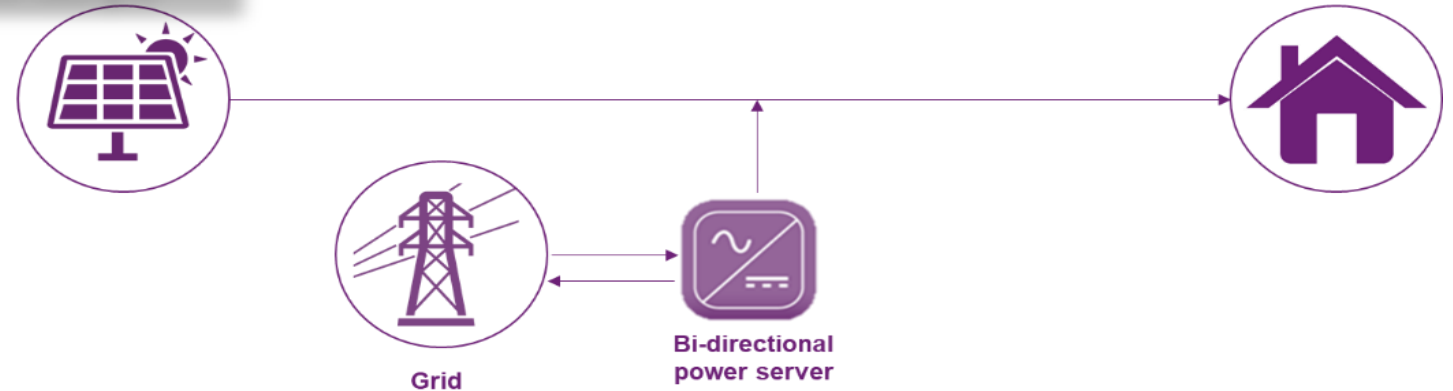


LVDC mini-grids

## AC mini grid



## DC mini grid

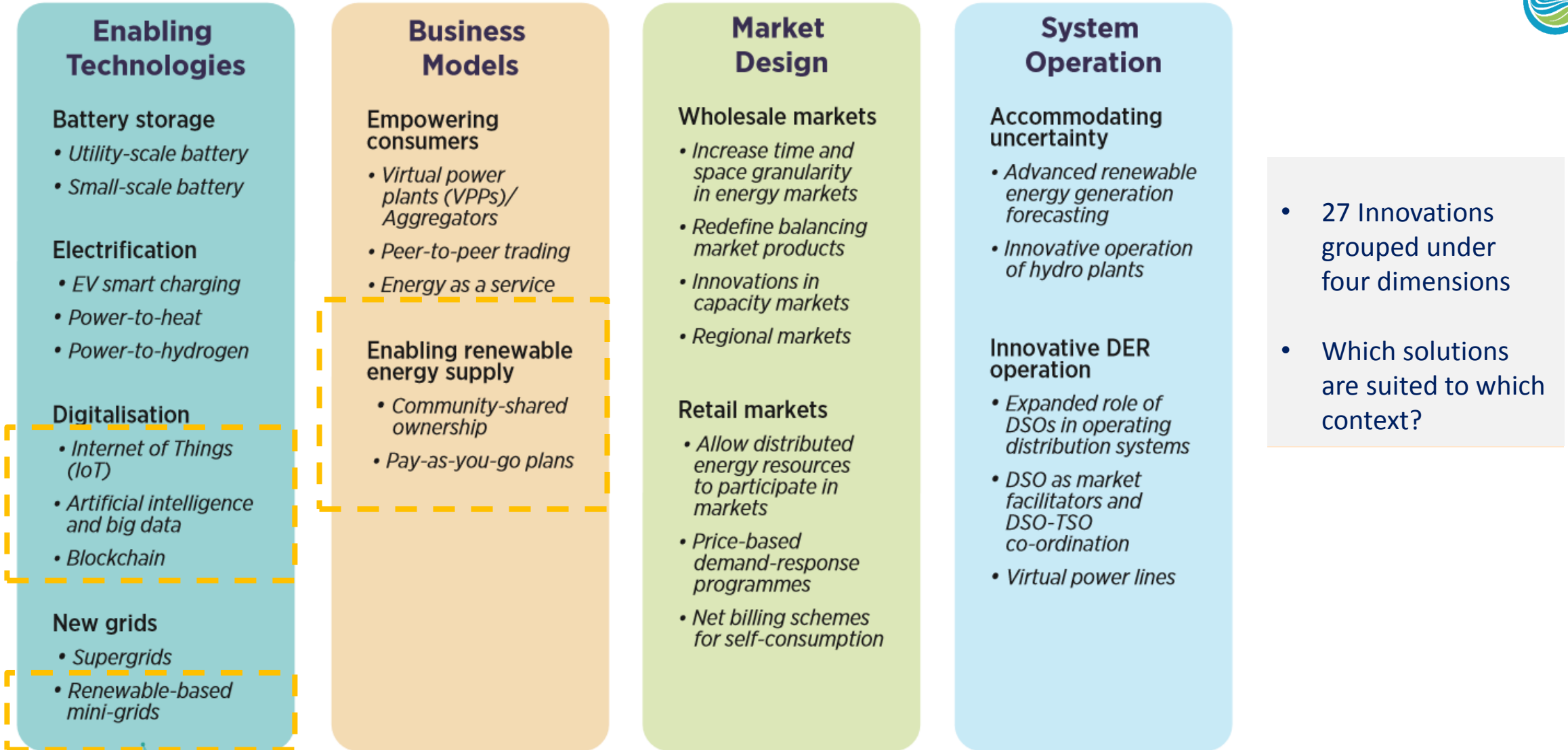


**DC reduces up to 10% the energy losses**

Source: IRENA (2016) Innovation Outlook: Renewable Mini-Grids



# Innovation Landscape for Renewable-Power Integration



# Innovation in control systems for mini-grids requires improved communication standards



Opportunity for Innovation	Cost	Reliability	Ease	Environment
More intelligent controls	★★★	★★★★★	★★★★★	★★
Improved communications and standards	★★	★★★★★	★★★★★	★
Improved metering and monitoring	★★	★★★	★★★★★	★★★
Simplify connecting equipment together	★★	★	★★★★★	★

## STATE OF THE ART TODAY

- Specialized and expensive controls
- Non-economic, non-predictive controls
- Moderate plug-and-play capability
- High utility interest, but limited to pilot projects
- Numerous competing standards
- One to two hours renewable resource prediction with high accuracy

## FUTURE

- Low cost modular controls
- Economic and predictive controls
- Seamless plug-and-play capability
- Standard interconnection terms for utilities
- Common, open-source standards
- Day-ahead renewable resource prediction with high accuracy