Scenario Development for Rural Electrification & Off-Grid Market and Mitigation Potential

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International Off-grid Renewable Energy Conference & Exhibition

1st of November 2018

The Reiner Lemoine Institut gGmbH (RLI)

Overview

- Not-for-profit research institute
- 100% owned by Reiner Lemoine Stiftung (RLS)
- Based in Berlin, established in 2010
- Managing director: Dr. Kathrin Goldammer
- 25 researchers + students

Alliance for Rural Electrification

SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK
A GLOBAL INITIATIVE FOR THE UNITED NATIONS

Mission

Scientific research for an energy transition towards **100 % Renewable Energy**

Reiner Lemoine
Founder of the Reiner Lemoine Foundation

Research Fields at RLI

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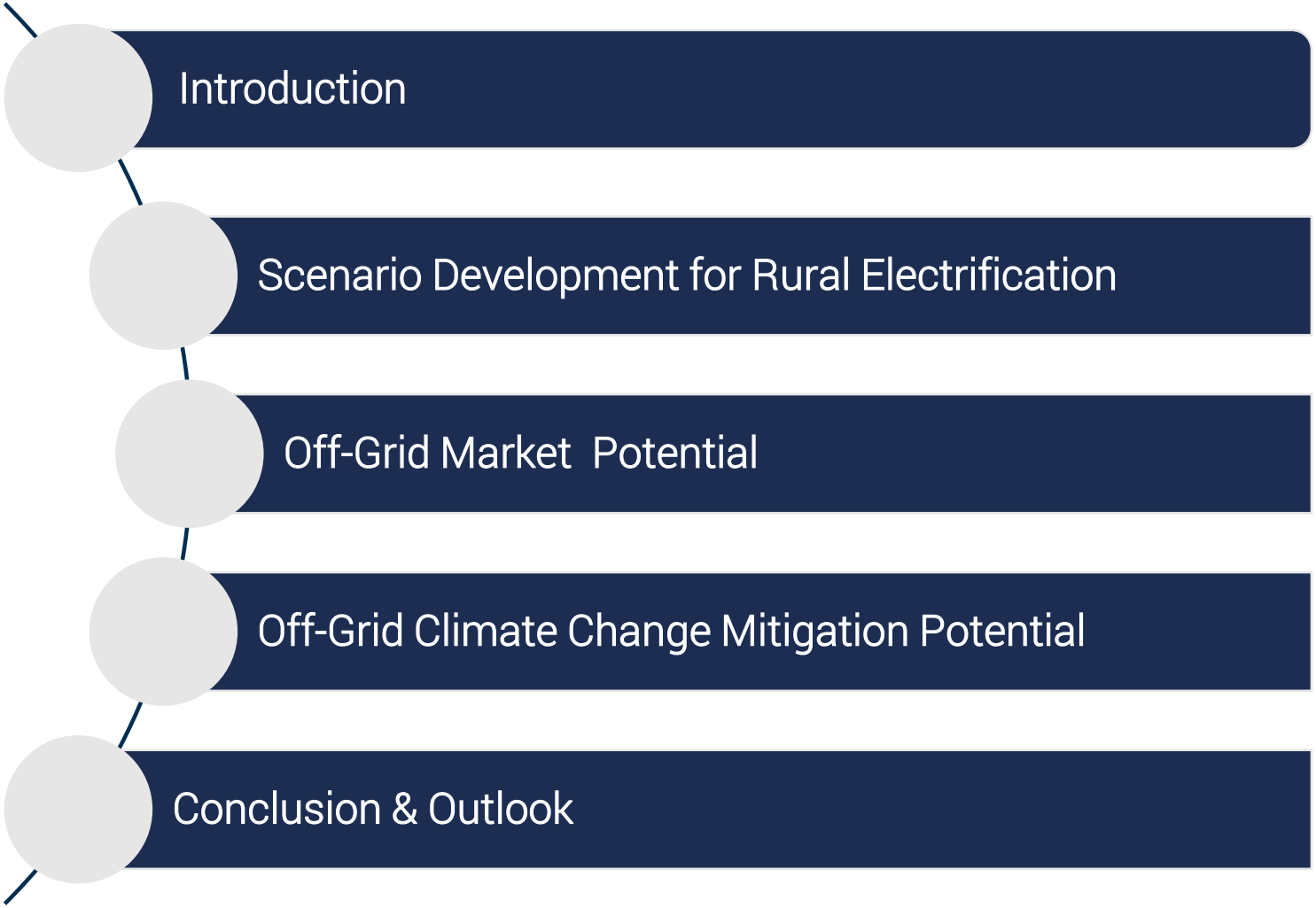
Transformation of Energy Systems	Off-Grid Systems	Mobility with Renewable Energy
" We analyze and optimize future scenarios with an energy supply largely based on renewable energy sources. "	"We support the development of sustainable energy supply for remote regions."	"We study sustainable mobility concepts through sophisticated implementation and optimization of renewable energy systems. "

- Strategic planning
- Geographic Information System
- Energy System Modelling
- Financial Assessment
- Market Potential Analysis

Agenda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Off-Grid Market Potential
Off-Grid Climate Change Mitigation Potential
Conclusion & Outlook

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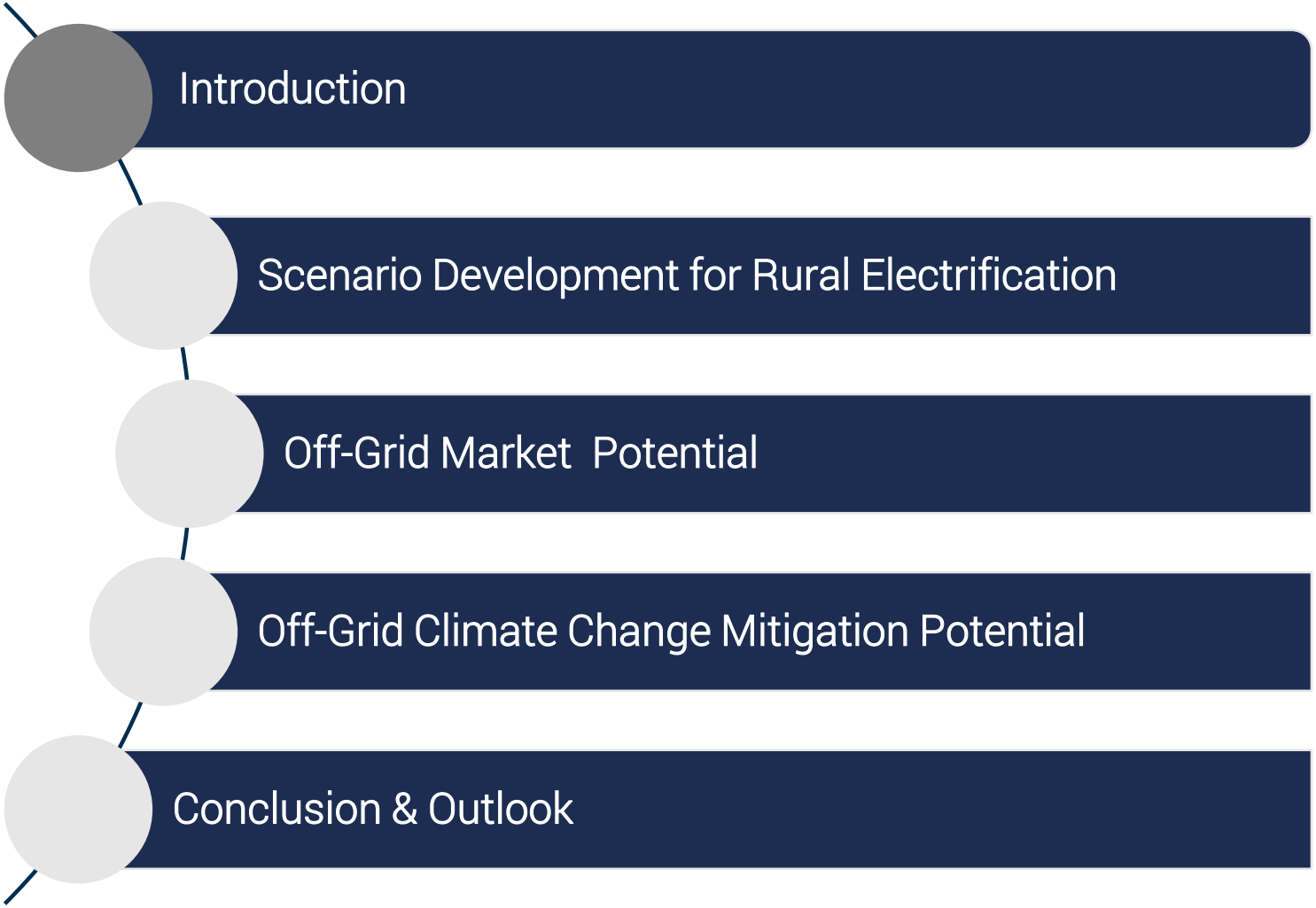
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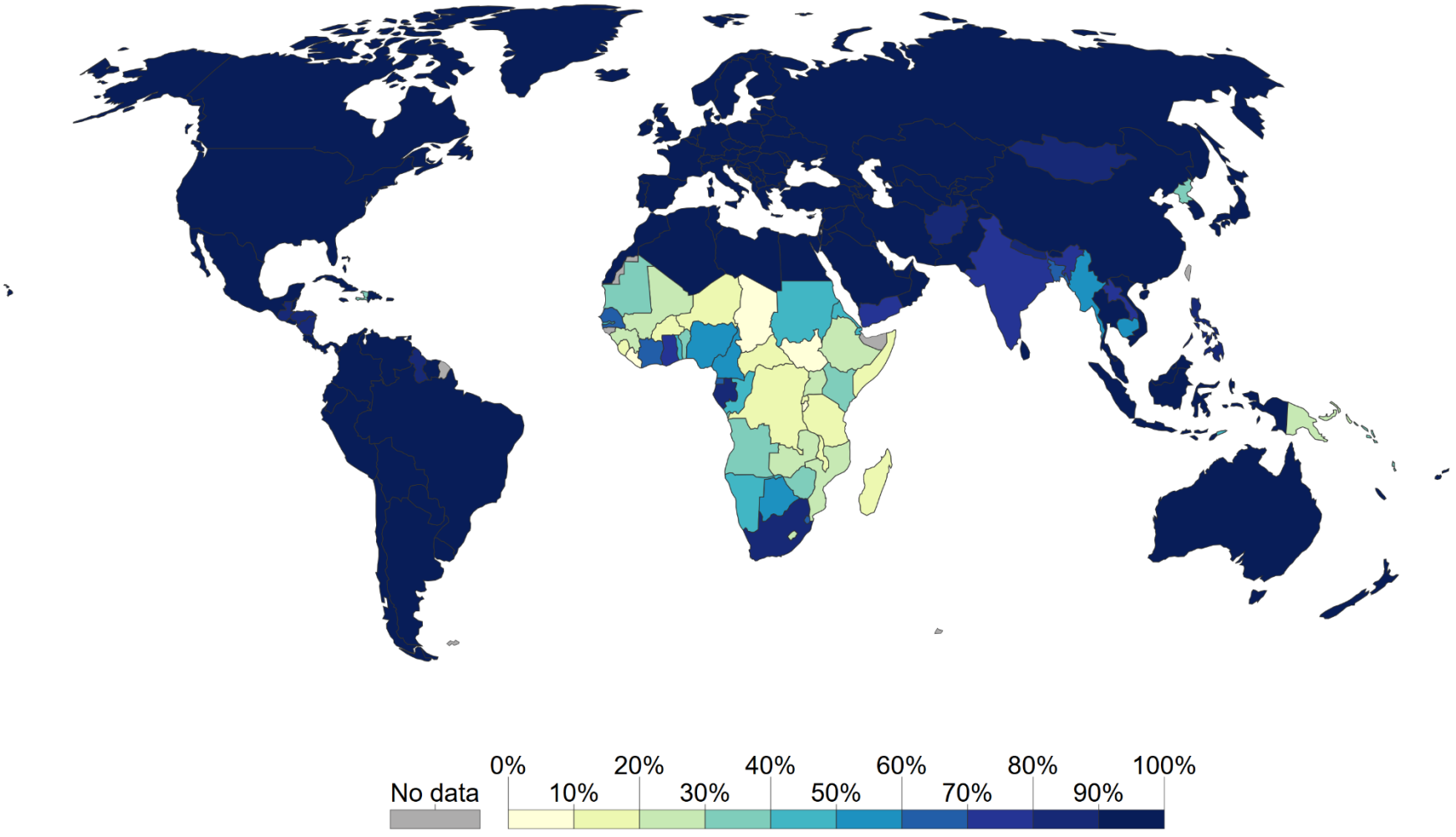
Motivation for improving electricity access

Share of the population with access to electricity, 2014

Data represents electricity access at the household level, that is, the number of people who have electricity in their home. It comprises electricity sold commercially, both on-grid and off-grid.



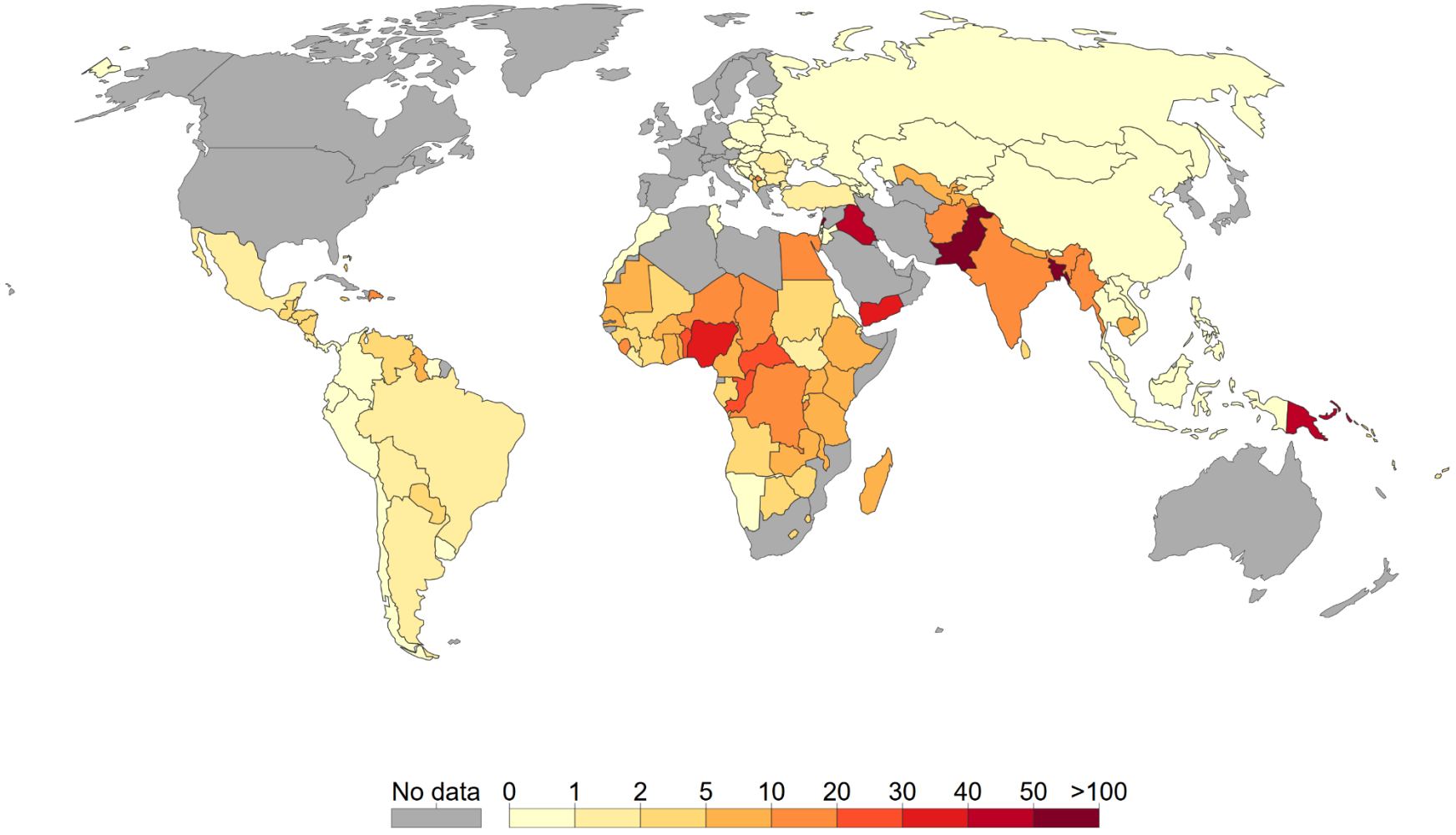
Source: The World Bank

OurWorldInData.org/energy-production-and-changing-energy-sources/ • CC BY-SA

Power outages in firms in a typical month

Power outages are the average number of power outages that establishments experience in a typical month.

Our World in Data



Source: World Bank – WDI

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Electrification Challenges and Opportunities

2030:
New Policies Scenario
Baseline Scenario of International Energy Agency

Number of people without access to electricity projected to fall **by 36%**
~ 390 Mio. people

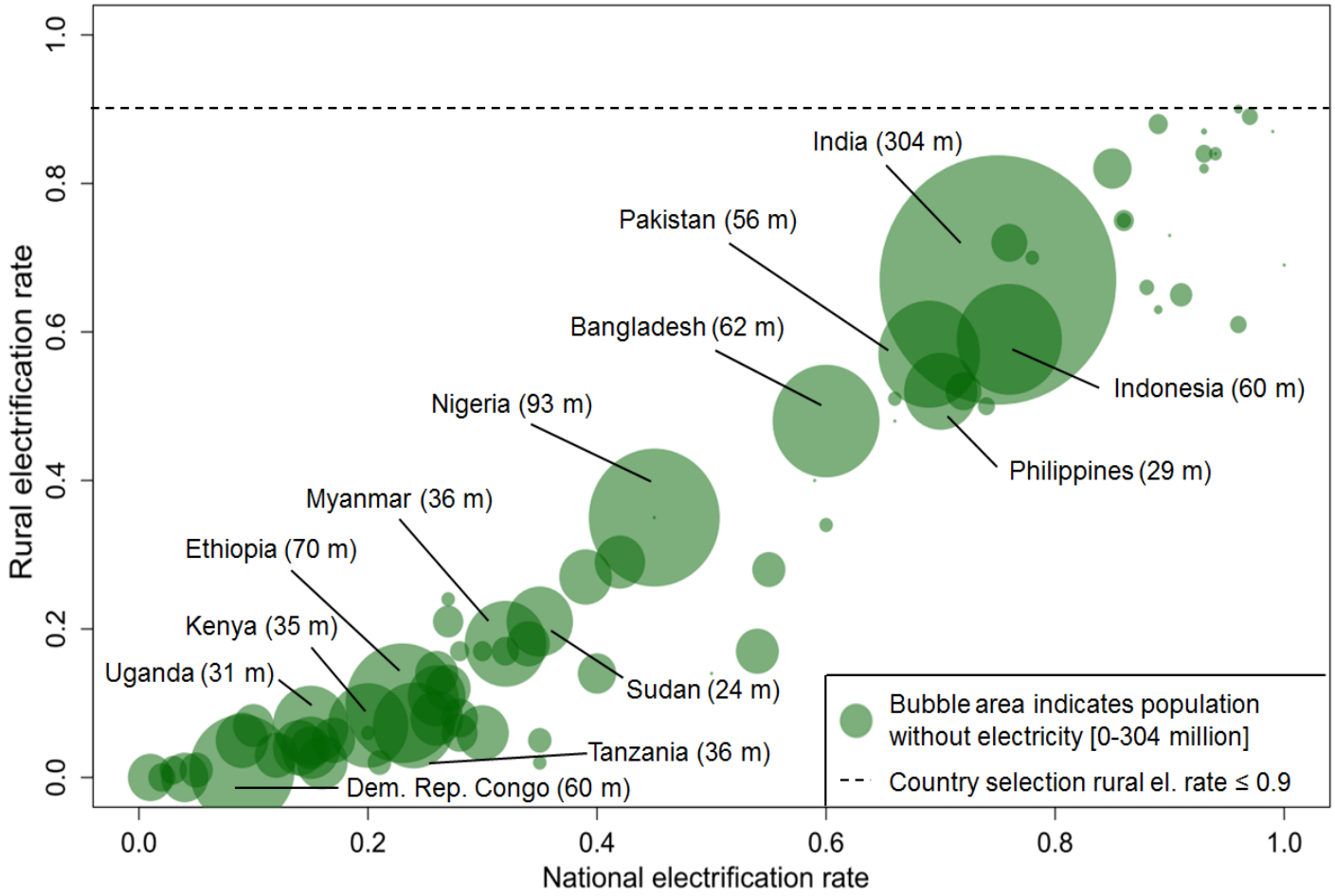
Still,
no energy access
for:

8 % of world population
~ 674 Mio. people without access

90 % of which will be **in rural areas**

International Energy Agency. (2017). *World Energy Outlook Special Report*.

Status Quo: Rural Electrification



International Energy Agency (2017). *World Energy Outlook Special Report*.

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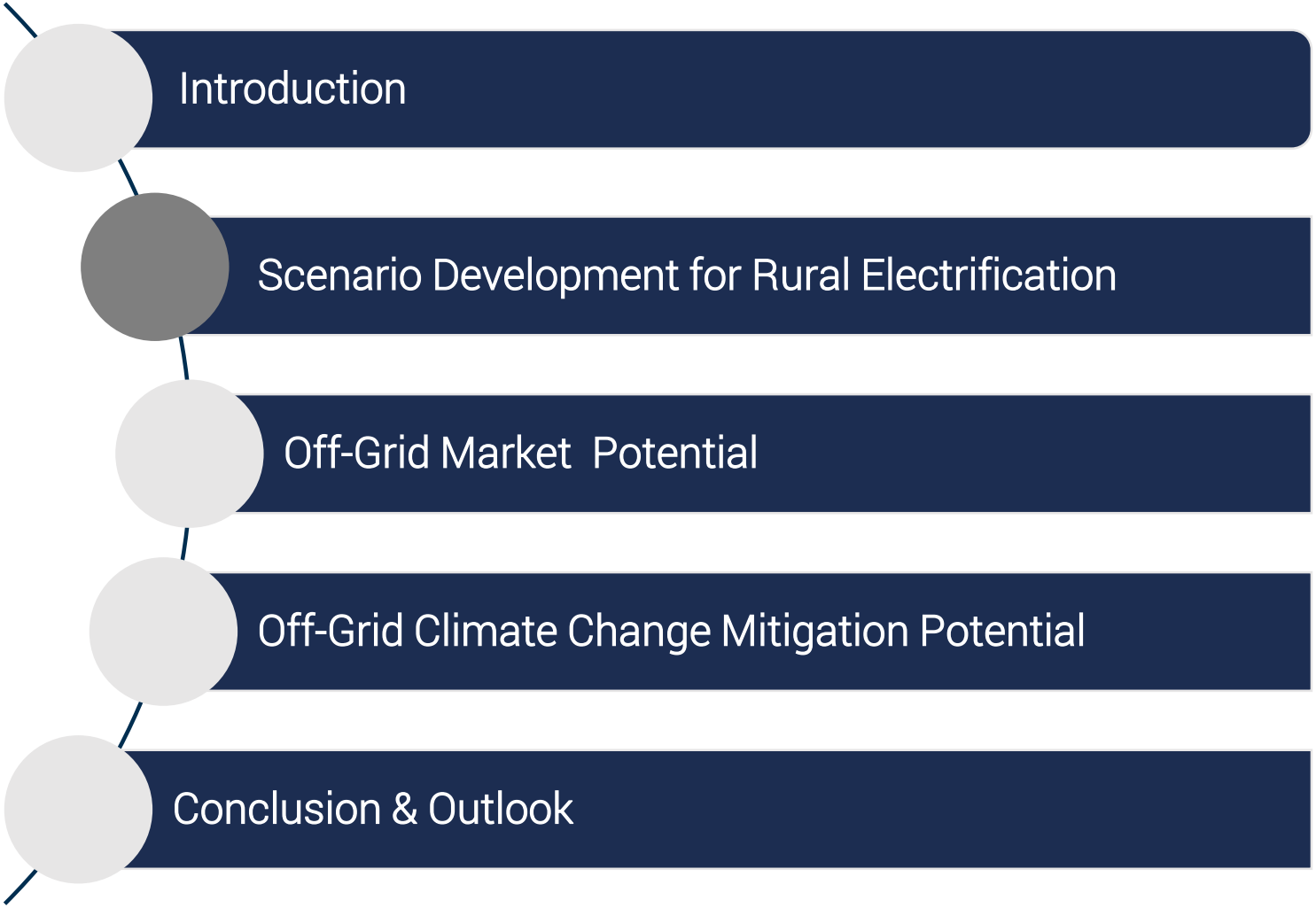
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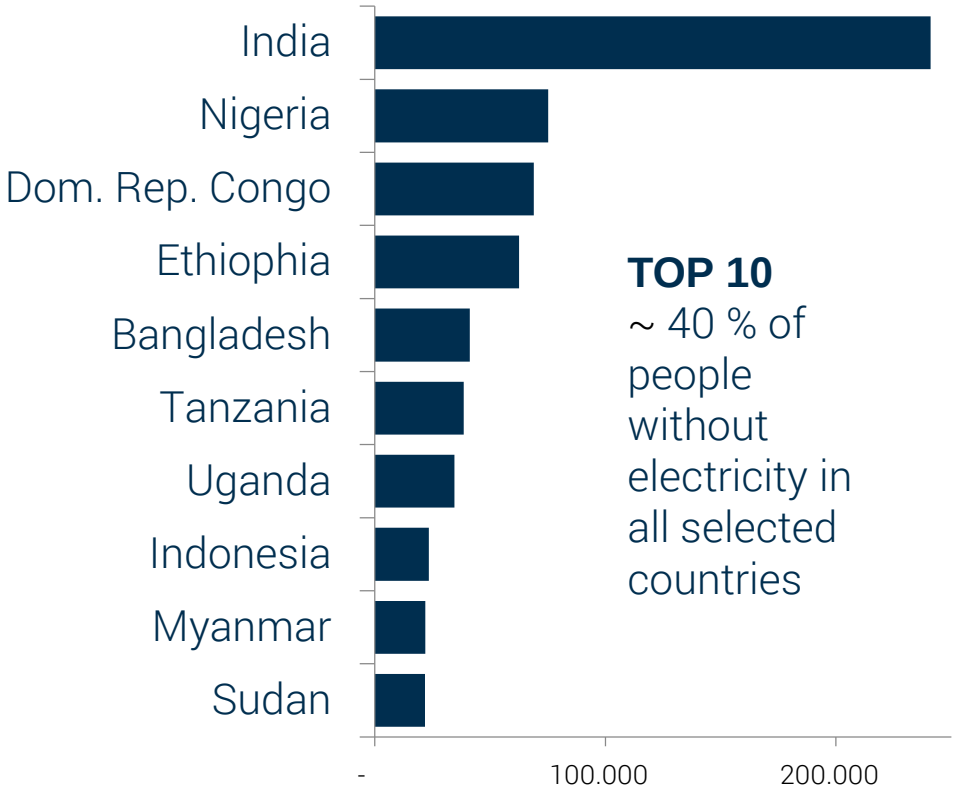
Country Selection



TOP 10
~ 40 % of people without electricity in all selected countries

Literature Analysis and Data Collection

+

Selection Criterion: Countries selected , if
>1 Mio. inhabitants without access
to electricity
52 countries selected

Scenario Development: Overview

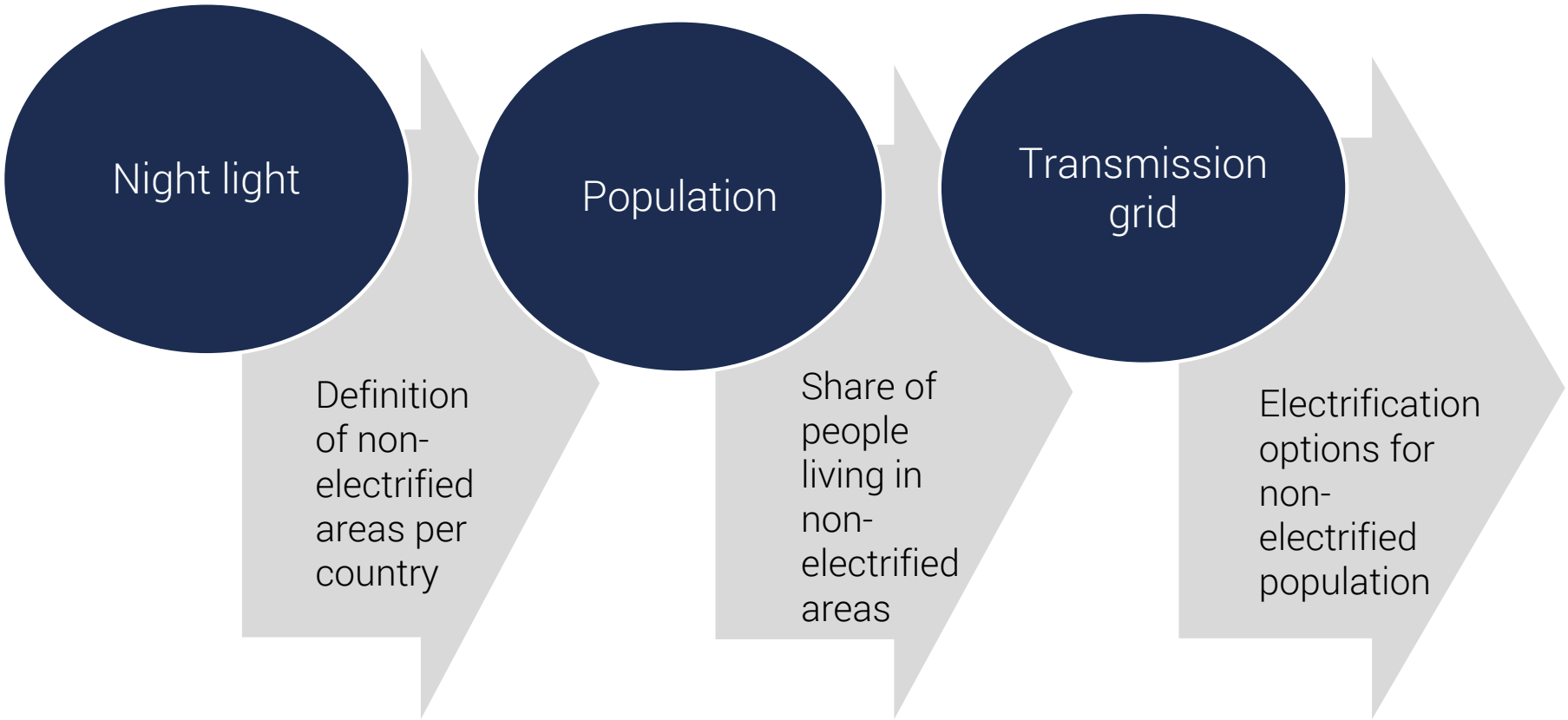
- Time horizon: 2030
- 100% access: Achieve SDG 7 most economically including all necessary measures and technology developments
- Scenario definition based on different Tier Levels[1)] (2-5), Population growth. Economic growth, in-country urbanization, migration

GIS based analysis

Game-Changer Assessment

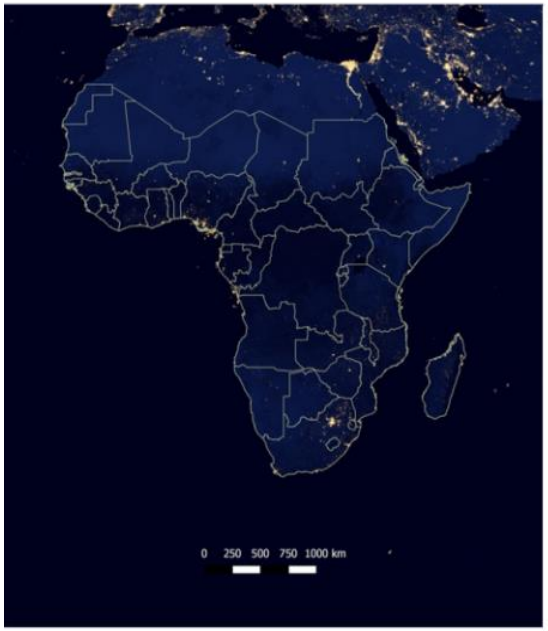
[1)] Based on Multi-Tier Framework by ESMAP

Base Scenario Development (GIS)

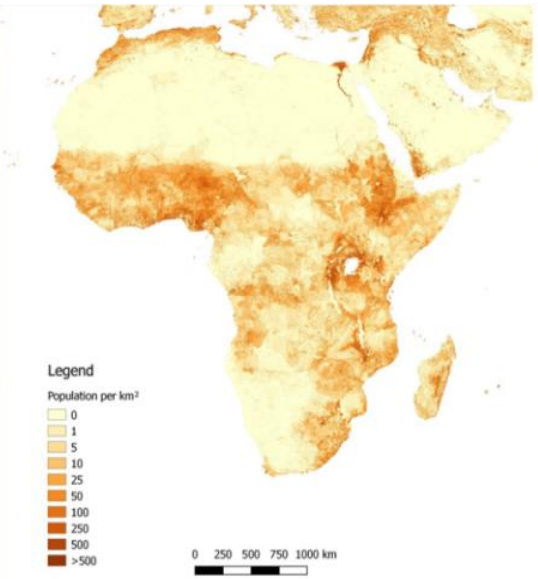


Base Scenario Development (GIS)

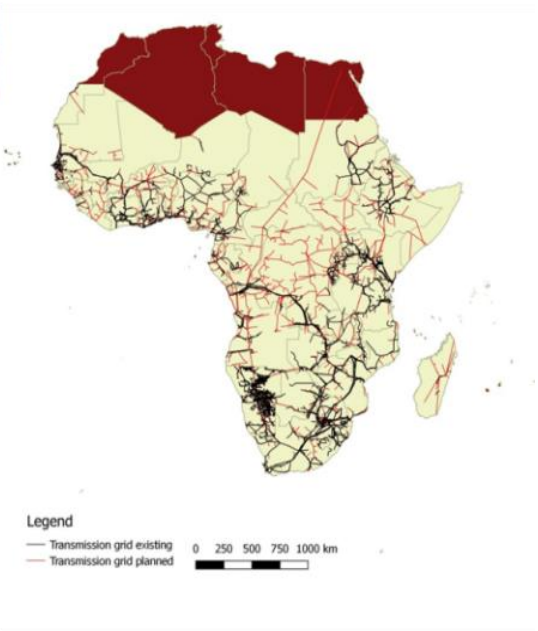
Step I - Night lights



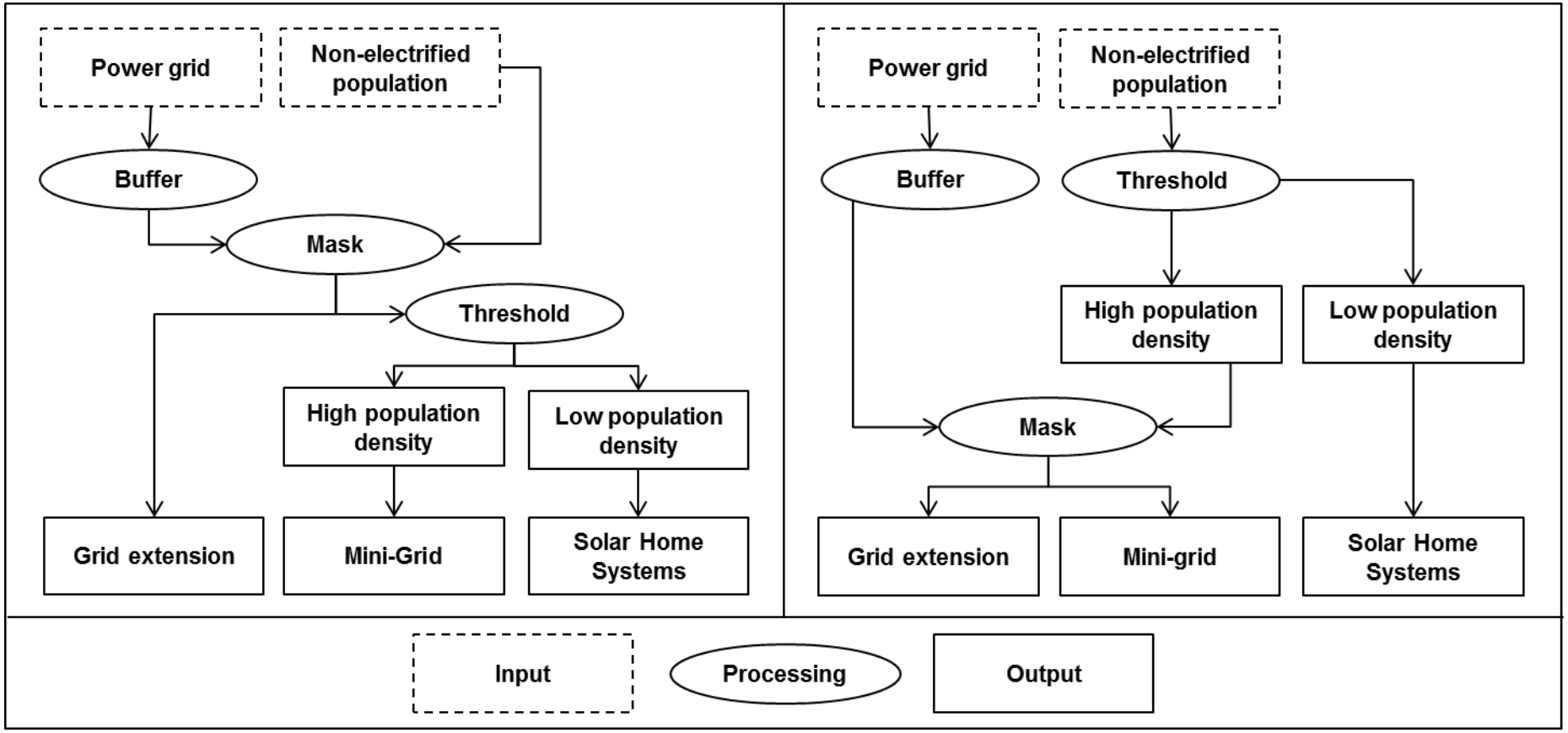
Step II - Population



Step III - Transmission grid

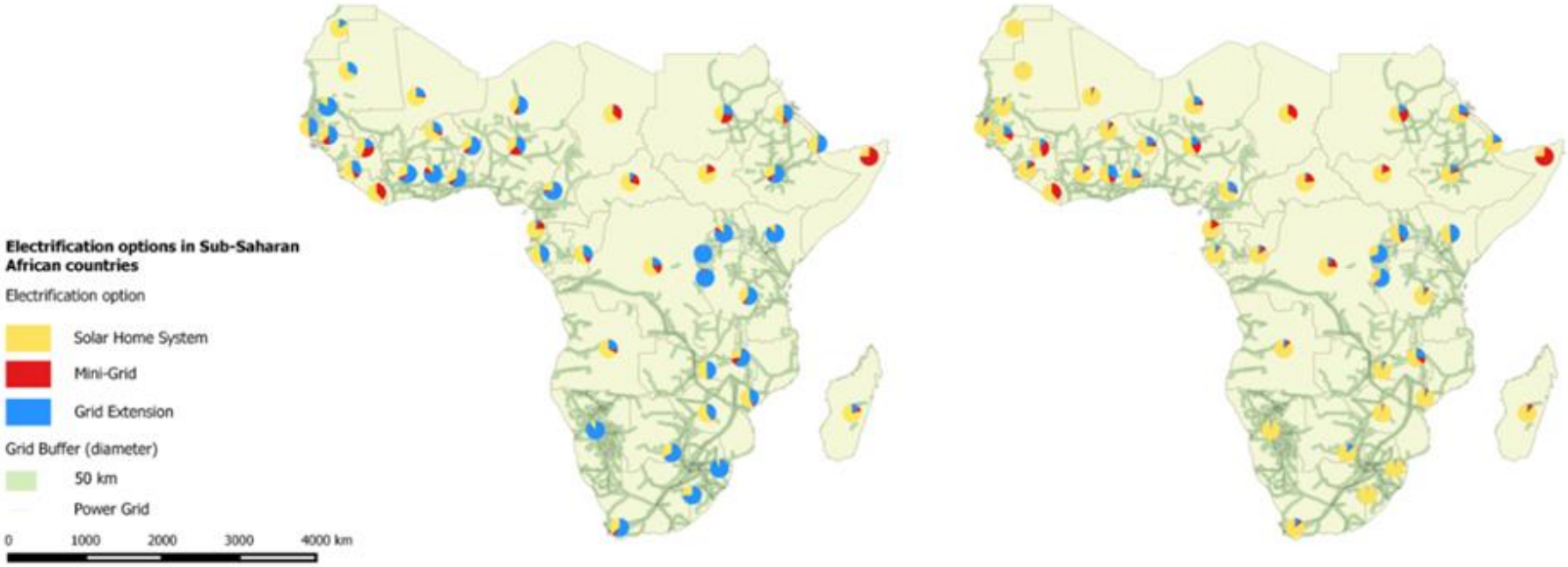


Base Scenario Development (GIS)



Base Scenario Development (GIS)

- Share and capacity (MW) of SHS, Mini-Grid, Grid Extension per country and scenario



Scenario Development: Overview

Base Scenario (GIS)
Population 2016

Base Scenario (Extrapolation)
Population 2030

+

100 % Tier 2	100 % Tier 3	100 % Tier 4	100 % Tier 5	mixed Tiers

= 10 scenarios

Game-Changer: Overview

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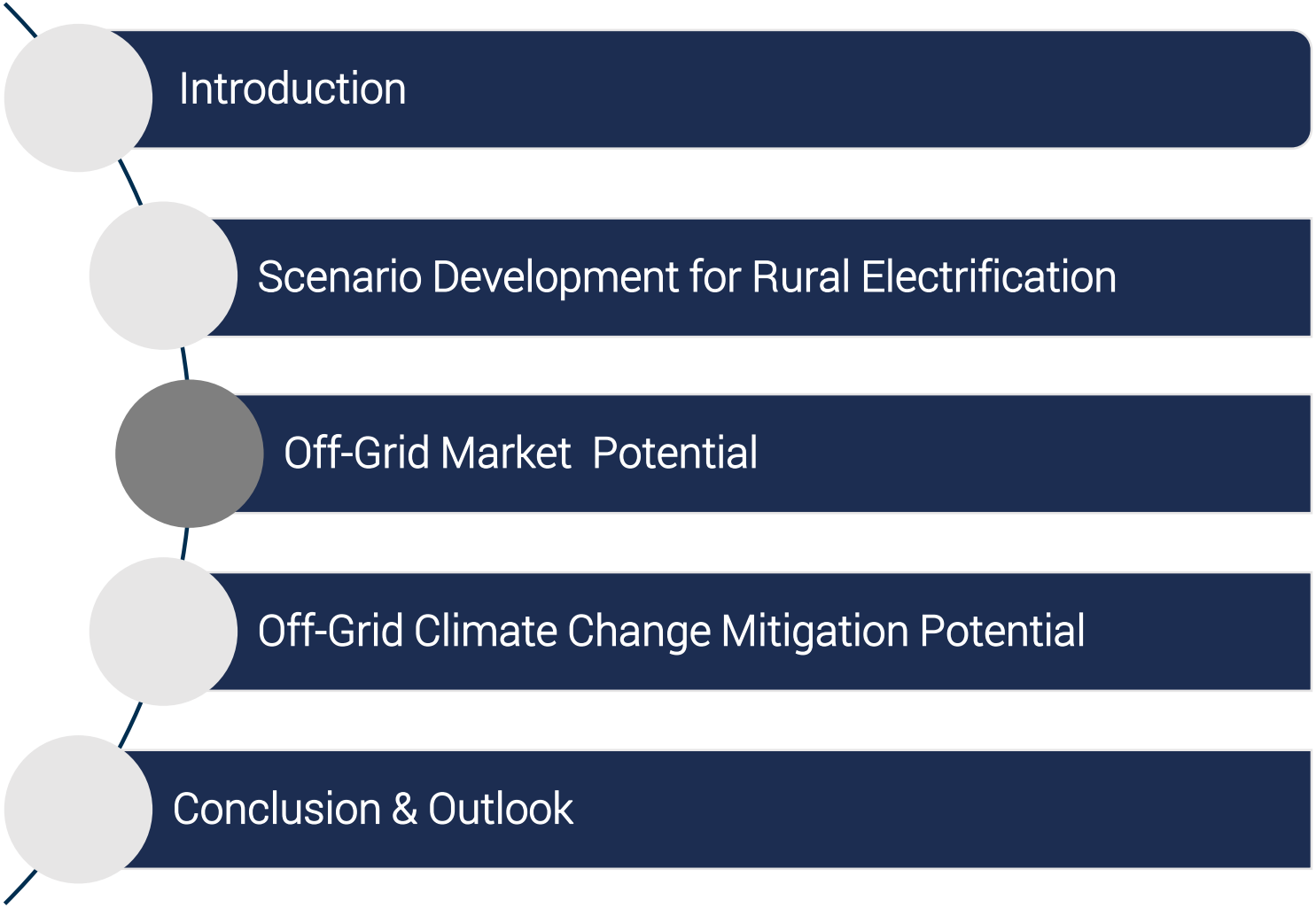
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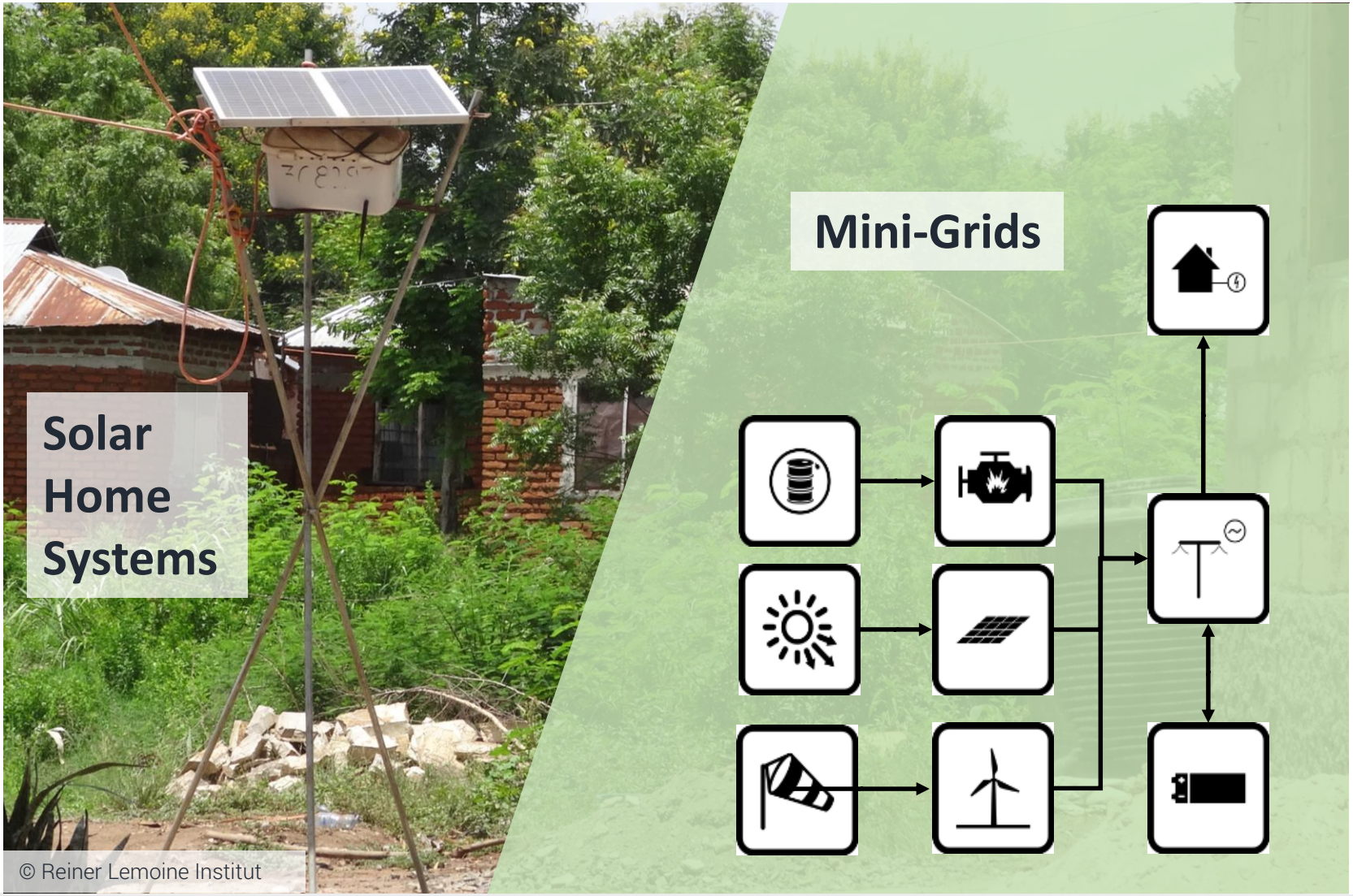
Off-Grid Electrification Opportunities



Off-Grid Market Potential

Cost estimation of SHS and Mini-Grid option per MW

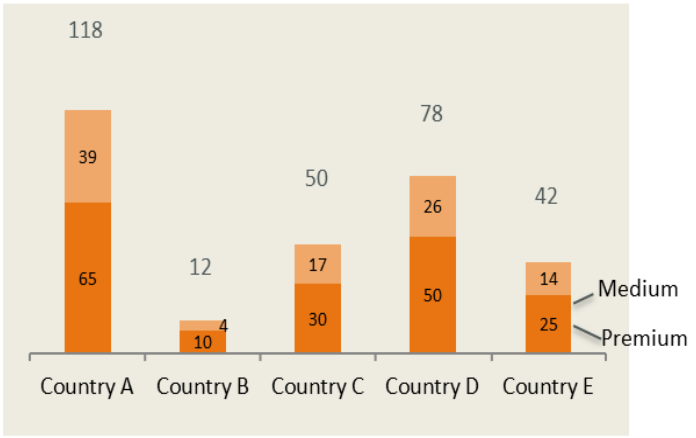
X

Forecasted capacity expansion

Underlying assumptions SHS – Example of Tanzania

	Category	Premium	Medium	Pico
Customer	Ppl. w/o access to electricity assigned to SHS	20 M		
	HHs / Pot. Customers [#]	8M (HH size of ~5)		
Solar Home System	Size range [W][1]	50+	11 – 49	3 – 10
	Customer share [%]	10%	20%	70%
	Monthly payment [USD]	15	5	2
		"Pay-as-you-go"		Reselling

SHS > 10W market potential [M USD p.a.]



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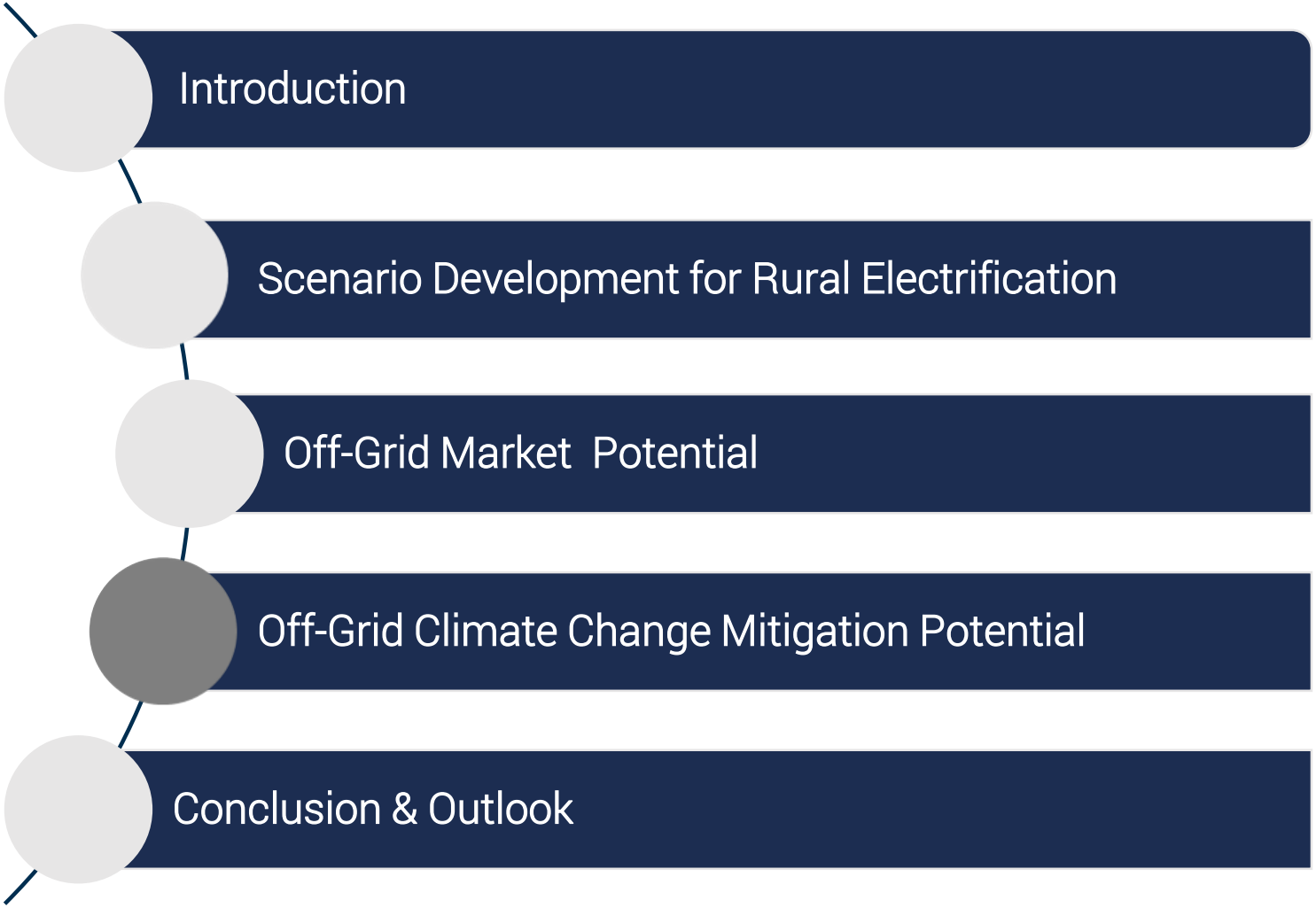
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Off-Grid Climate Change Mitigation Potential

- Emission accounting achieved by standards and methods under the Clean Development Mechanism (CDM)
- Combination of approved CDM baseline methods and country-specific standardized baselines (SBs) under the UNFCCC

$$ER_y = BE_y - PE_y - LE_y$$

ER_y = Emission reductions in year y (t CO_2e/y)

BE_y = Baseline Emissions in year y (t CO_2/y)

PE_y = Project emissions in year y (t CO_2/y)

LE_y = Leakage emissions in year y (t CO_2/y)

Off-Grid Climate Change Mitigation Potential

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Example: Mini-Grid (MG) Baseline Emissions

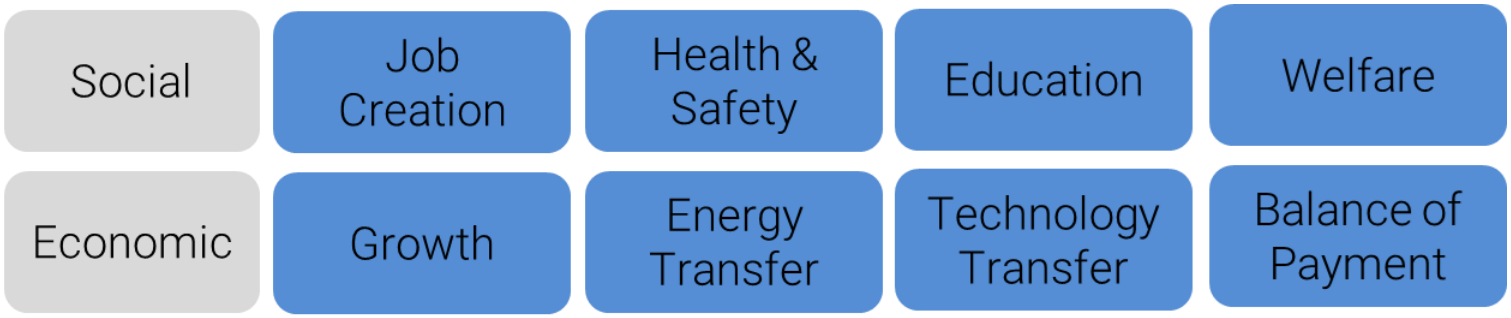
$$BE_{MG} = EF[kg\ CO_2eq\ kWh] \times expected\ annual\ RE\ generation\ [kWh]$$

CDM AMS-I.F Emission factors (EF) for diesel-based Mini-Grid CDM in kg CO2e/kWh

	MG with 24 hr service	a) MG with temporary service (4-6 hr/day) b) productive applications c) water pumps	MG with storage
Load Factors	25%	50%	100%
Sizes			
< 15 kW	2.4	1.4	1.2
>=15< 35 kW	1.9	1.3	1.1
>= 35 < 135 kW	1.3	1	1
>=135 < 200 kW	0.9	0.8	0.8
> 200 kW	0.8	0.8	0.8

Impact Assessment

Socio- Economic Impact



Example: Environmental Impact

- Deforestation: change in cooking demand to more efficient or electrical stoves are derived based on the Multi-Tier Framework by ESMAP

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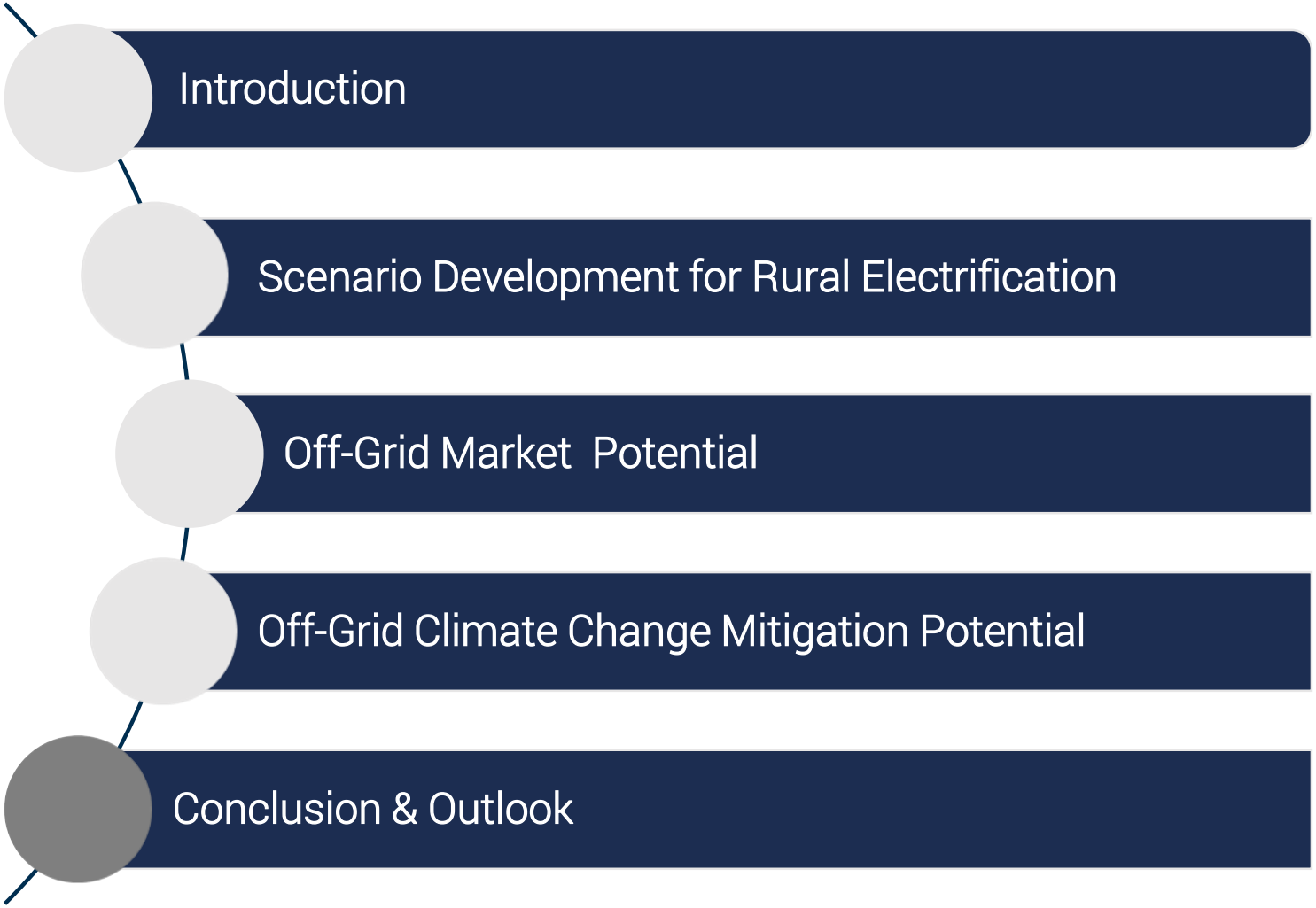
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Conclusion

- Achieving SDG7 until 2030 is an immense task
- Off-grid technologies will play a key role in achieving this goal
- Climate relate emissions will increase with higher electrification rates
- Scenario development will create an overall understanding of market potentials of different technologies and effects of electrification
- Impacts of electrification on climate need to be understood in order to create the right policies for the focus on renewable energy-based technologies

Measures towards reaching SDG7 needs to be in line with reaching SDG13

Thank you for your attention!

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