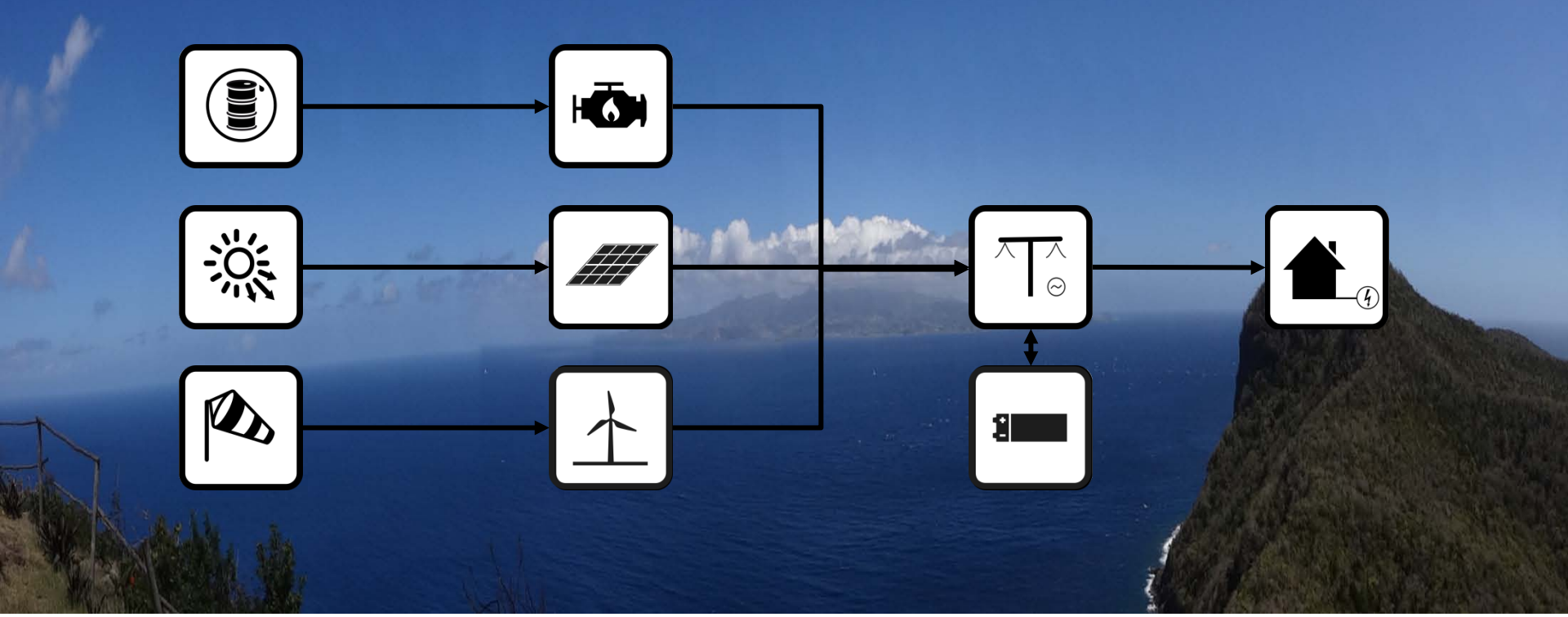

Global PV market potential for small island energy systems

Philipp Blechinger
Intersolar – Munich
12th of June 2015

REINER LEMOINE INSTITUT

Reiner Lemoine Institut

Overview

- Not-for-profit research institute
- 100% owned by Reiner Lemoine Stiftung (RLS)
- Based in Berlin, established in 2010
- Managing director: Dr. Claus Beneking
- 25 research assistants + students
- Member of e.g. ARE, eurosolar, BNE

Alliance for Rural Electrification

EUROSOLAR

BERLIN BRANDENBURG ENERGY NETWORK e.V.

Reiner Lemoine
Founder of the Reiner Lemoine Foundation

Mission

Scientific research for an energy transition towards **100 % renewable energies**

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Research fields - RLI

Optim. Energy Systems and Transition	Off-Grid Systems	Mobility with Renewable Energies
▪ Simulation of integrated energy systems ▪ Modelling of energy supply including storage options (e.g. batteries, PtG) ▪ Feasibility studies for energy supply by GIS ▪ Energy transition and social acceptance	▪ Rural electrification planning ▪ Simulation of hybrid mini-grids ▪ Combination of GIS analyses and energy system simulations ▪ Market research and business strategies	▪ Mobility concepts with renewable energies ▪ Research on electrolyses and PtG ▪ Implementation of hybrid mini-grids and small wind turbines ▪ Hardware in the loop testing and measurements

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Agenda

- Motivation
- Island detection
- Demand analysis
- PV potential
- Conclusion

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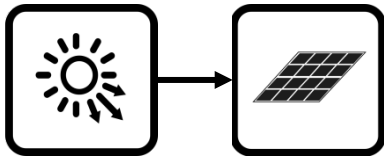
Motivation

Unfavorable conditions in on-grid markets for PV increase the need for new emerging markets:

- Competitive PV projects without subsidies
- Complex systems allow technological advantages



➢ **Diesel mini-grids** represent an interesting new market field based on **high fuel costs** and technologically challenging **integration of PV**

Small islands (> 100,000 inhabitants) are **geographically defined mini-grids**:
Where are these islands?
What is their electricity demand?
What is the related PV potential?

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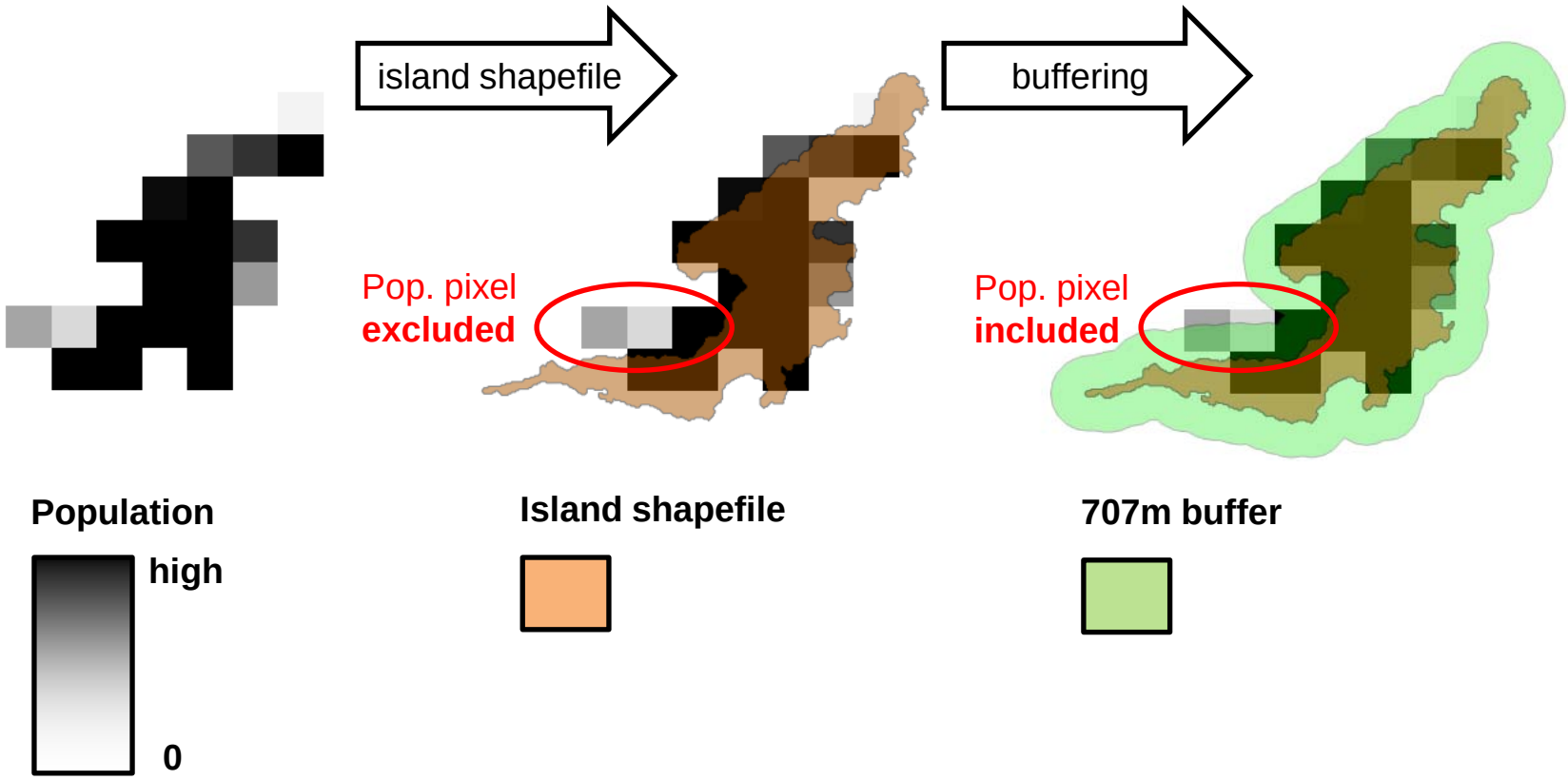
Where are small islands?



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Global small island overview

Region	Number of Islands	Population (av.)	Population (sum)	GDP (av.) [EUR/cap]
Atl. + Arct. Oc.	416	9,985	4,150,000	18,200
Caribbean +	105	16,160	1,700,000	14,600
Indian Ocean	232	12,210	2,830,000	2,960
Mediterr. Sea	104	10,540	1,100,000	23,500
Pacific Ocean	1,199	9,690	11,620,000	8,660
Total	**2,056**	**10,410**	**21,400,000**	**14,300**

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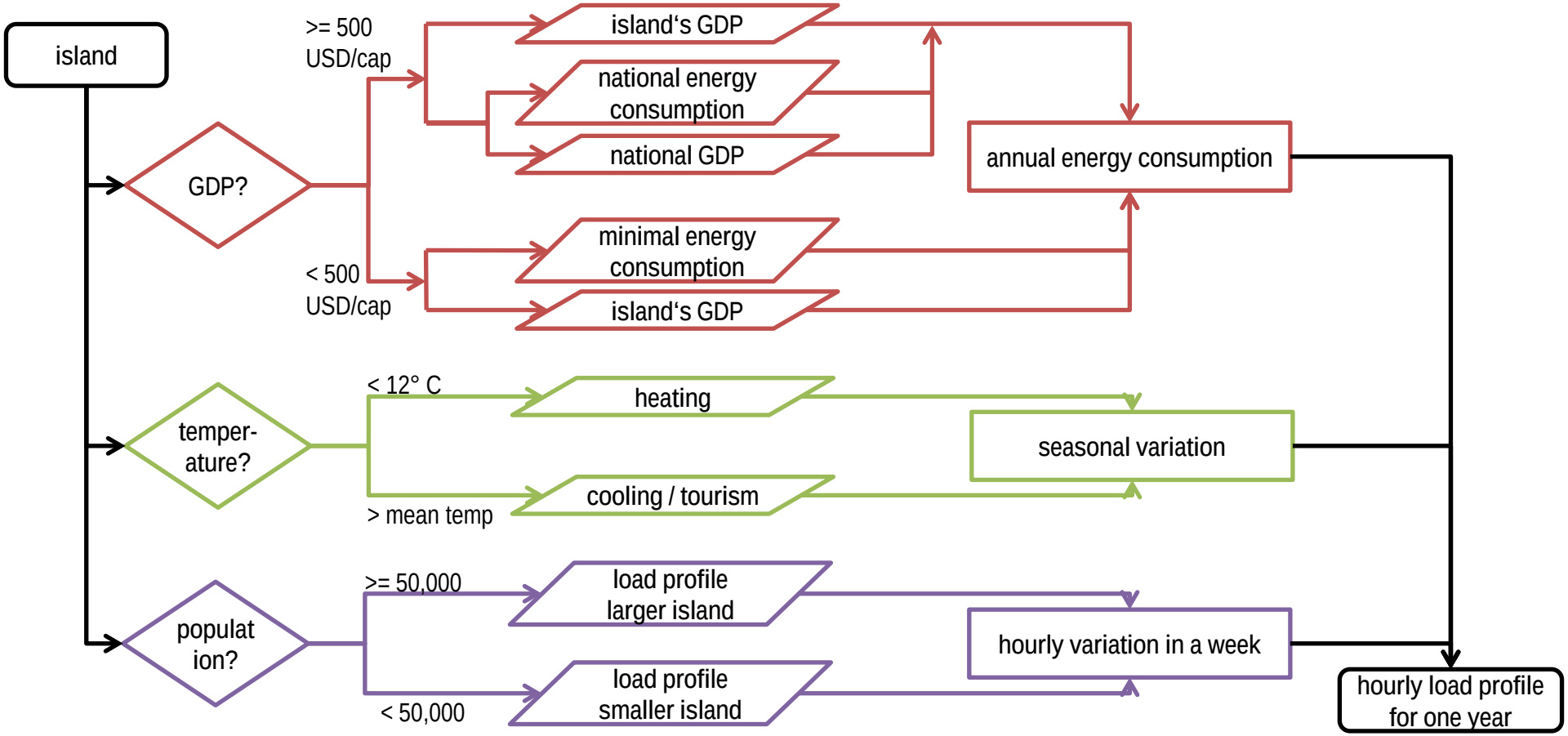
What is the energy demand?



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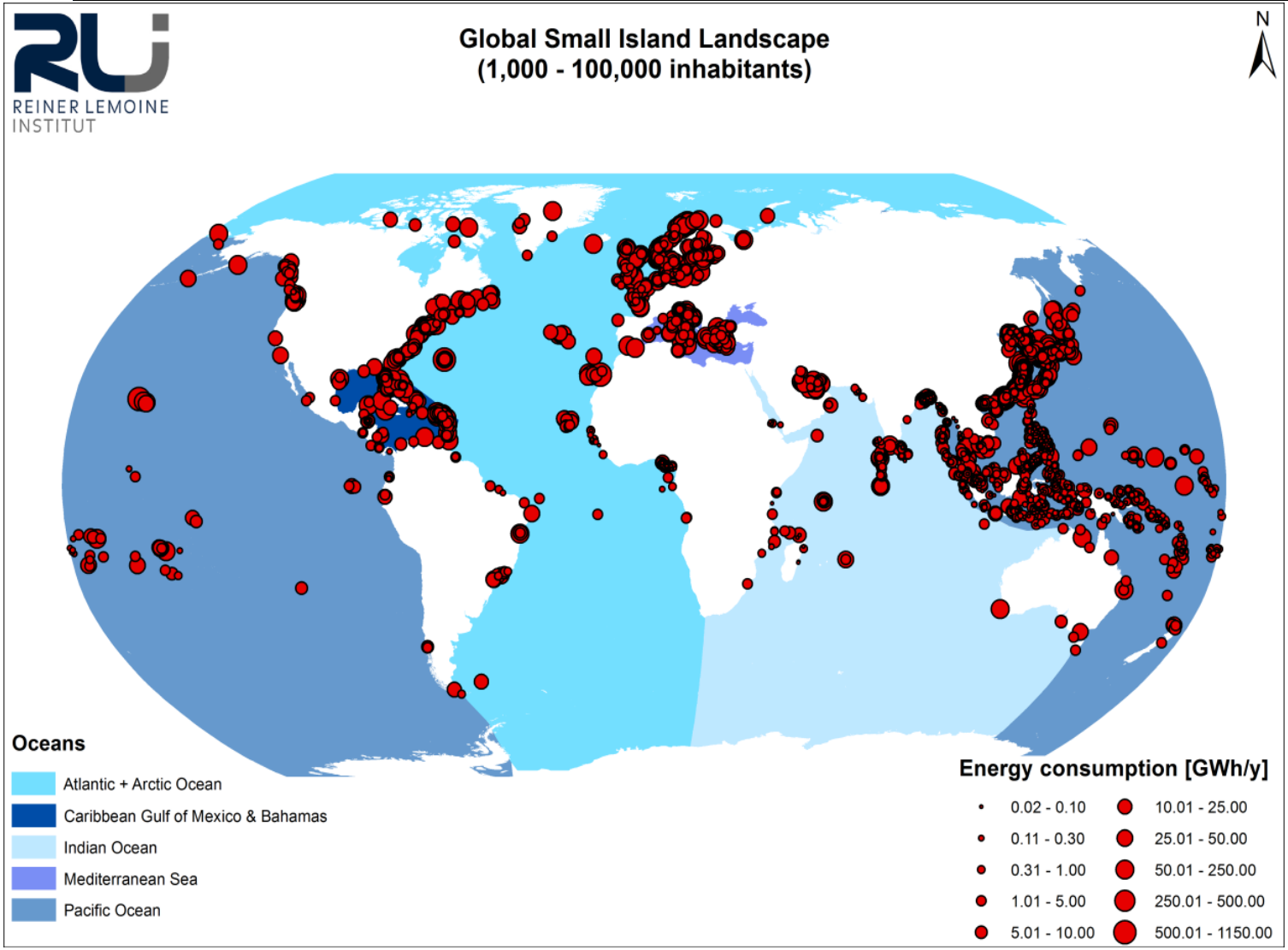
Island demand overview



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Island demand overview and conventional power system

Region	El. cons. (sum) [GWh/year]	El. cons. (av.) [MWh/year]	El. cons. (av. per cap.) [kWh/year* cap]	LCOE Diesel only (av.) [EURct/kWh]
Atl. + Arct. Oc.	18,270	43,920	4,400	36.6
Caribbean +	5,710	54,380	3,370	34.2
Indian Ocean	2,240	9,660	790	38.0
Mediterr. Sea	3,680	35,390	3,345	33.2
Pacific Ocean	22,730	18,970	1,960	39.3
Total	**52,630**	**25,600**	**2,462**	**38.0**

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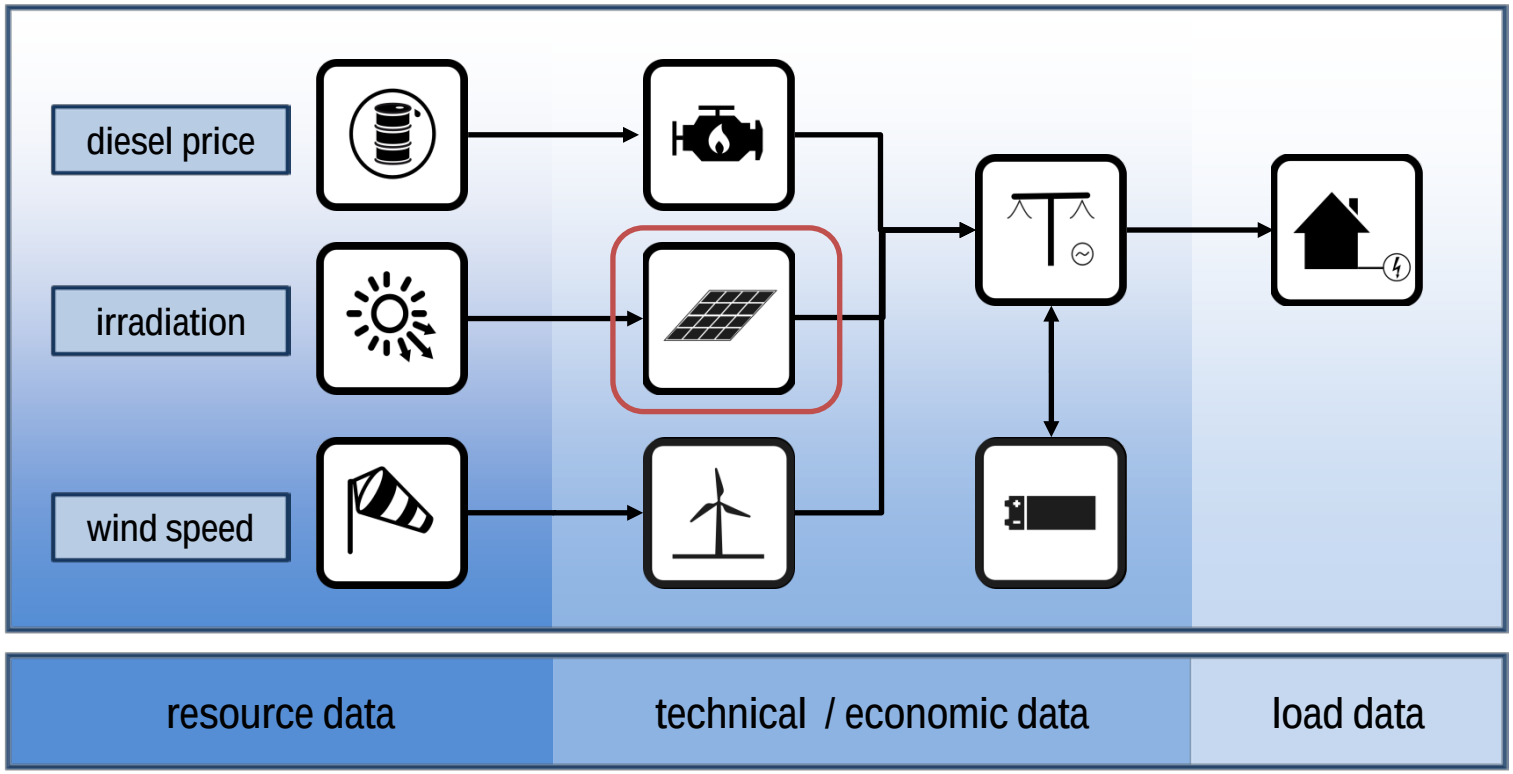
Energy system simulation



PV Capex of 2,000 €/kW

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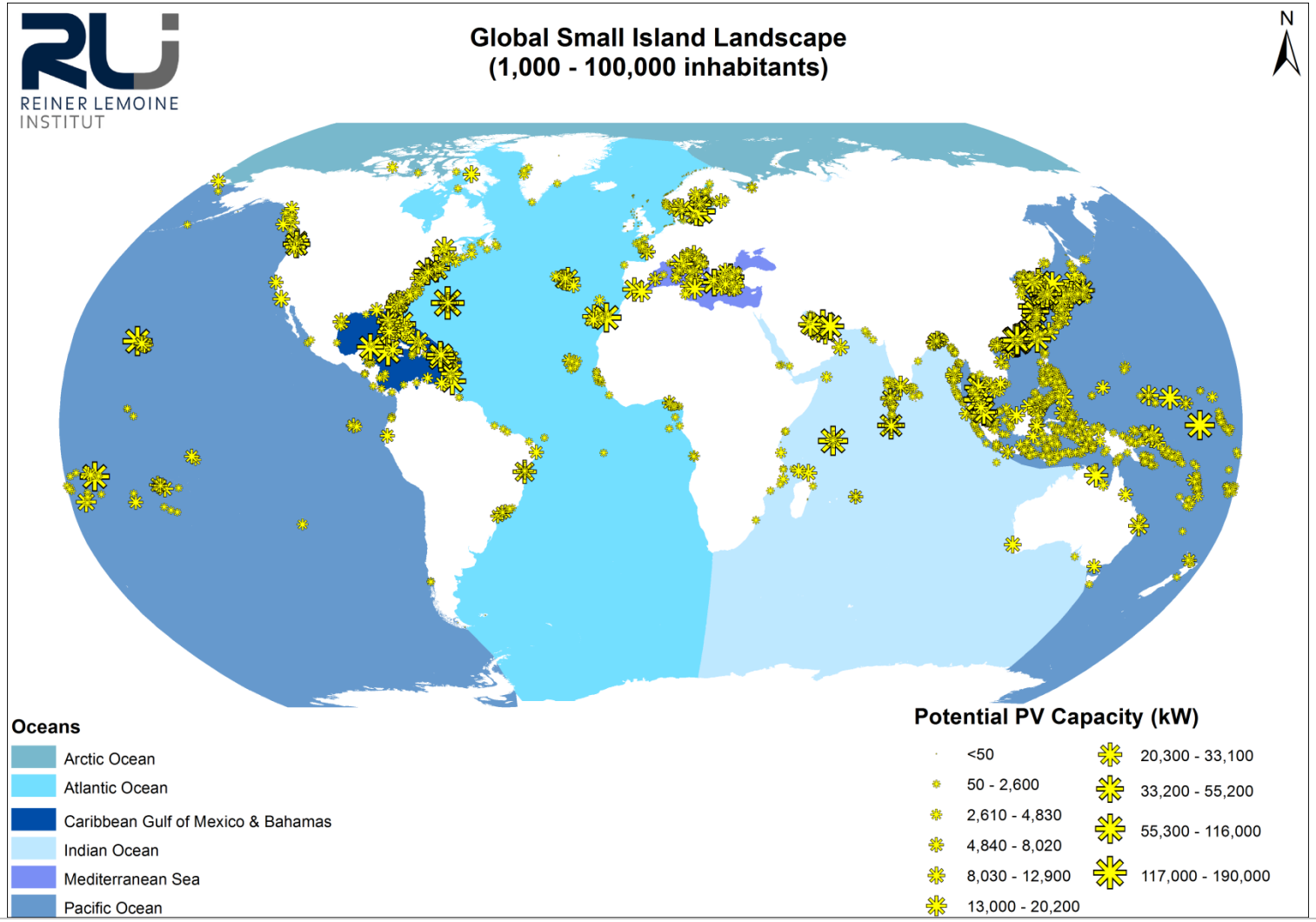
PV potential on islands - map



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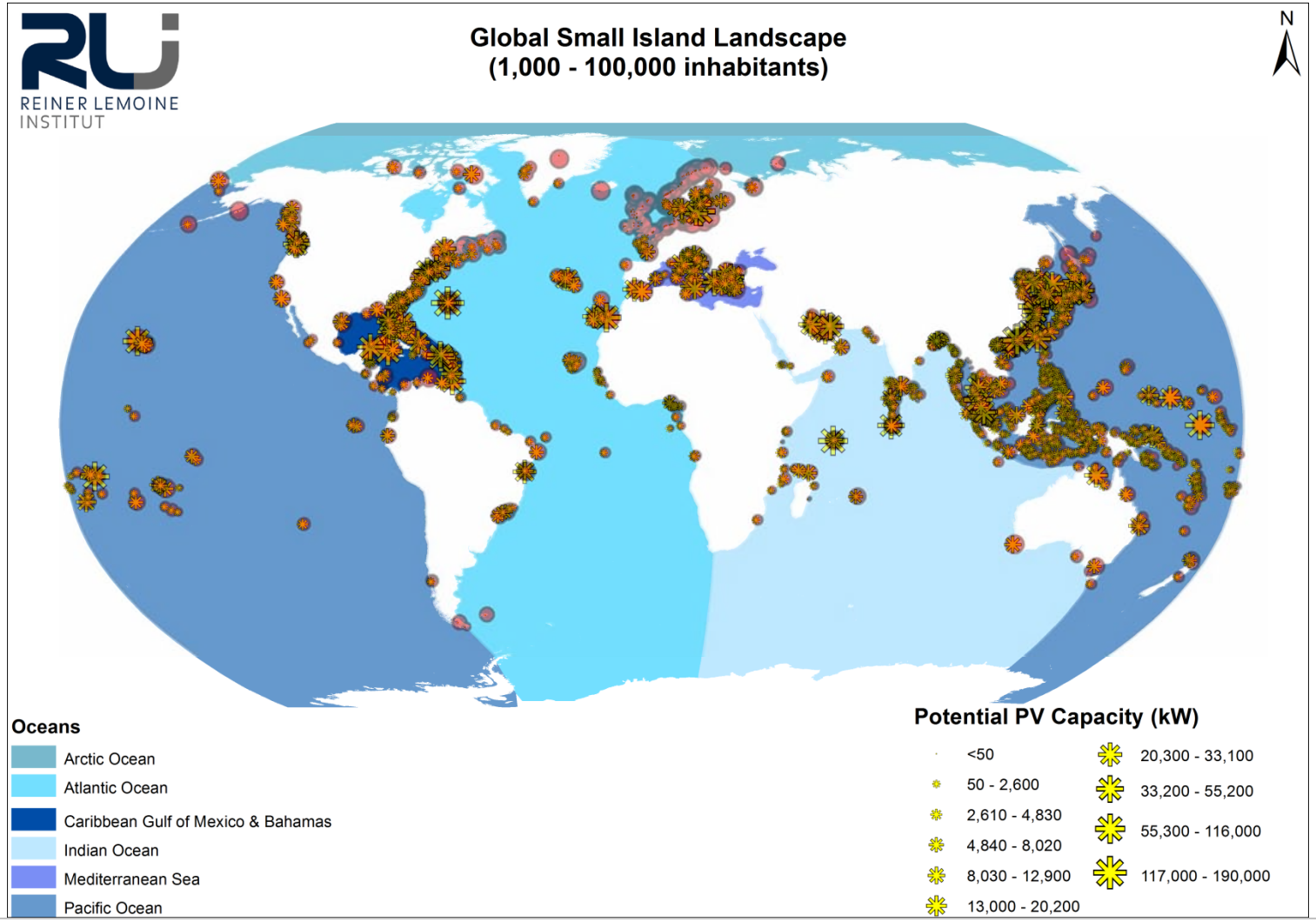
Island demand overview



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PV potential on islands - numbers

Region	Scenario	PV (sum) [MWp]	Wind (sum) [MW]	Storage (sum) [MWh]	LCOE (av.) [EURct/kWh]	RE share (av.)
Atl. + Arct. Oc.	Scen I	930	5,320	n/a	26.3	48%
	Scen II	+21%	-1%	930	-1.9%	58%
Caribbean +	Scen I	910	1,210	n/a	24.3	57%
	Scen II	+9%	-2%	360	-1.6%	65%
Indian Ocean	Scen I	420	370	n/a	29.7	44%
	Scen II	+76%	-30%	1,240	-6.7%	65%
Mediterr. Sea	Scen I	550	770	n/a	25.8	47%
	Scen II	+10%	-1%	230	-1.2%	55%
Pacific Ocean	Scen I	3,390	5,090	n/a	30.2	44%
	Scen II	+19%	-5%	2,550	-7.0%	71%
Total	**Scen I**	**6,200**	**12,760**	**n/a**	**30.2**	**46%**
	Scen II	**+21%**	**-4%**	**5,310**	**-5.6%**	**71%**

Scenario I w/o battery storage
Scenario II with battery storage

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Conclusion

A huge untapped techno-economic potential exists for PV implementation on small islands.

- PV with storage outperforms diesel only systems on many tropical and sub-tropical islands.
- Economic and ecological advantages should accelerate the implementation of PV systems on small islands.

Remaining challenges are

- High transaction costs for single projects
- Fossil fuel subsidies
- Lack of financing opportunities

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