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Final workshop

Analysis of the transition to adaptation in harmony with mitigation

Sub-theme 3
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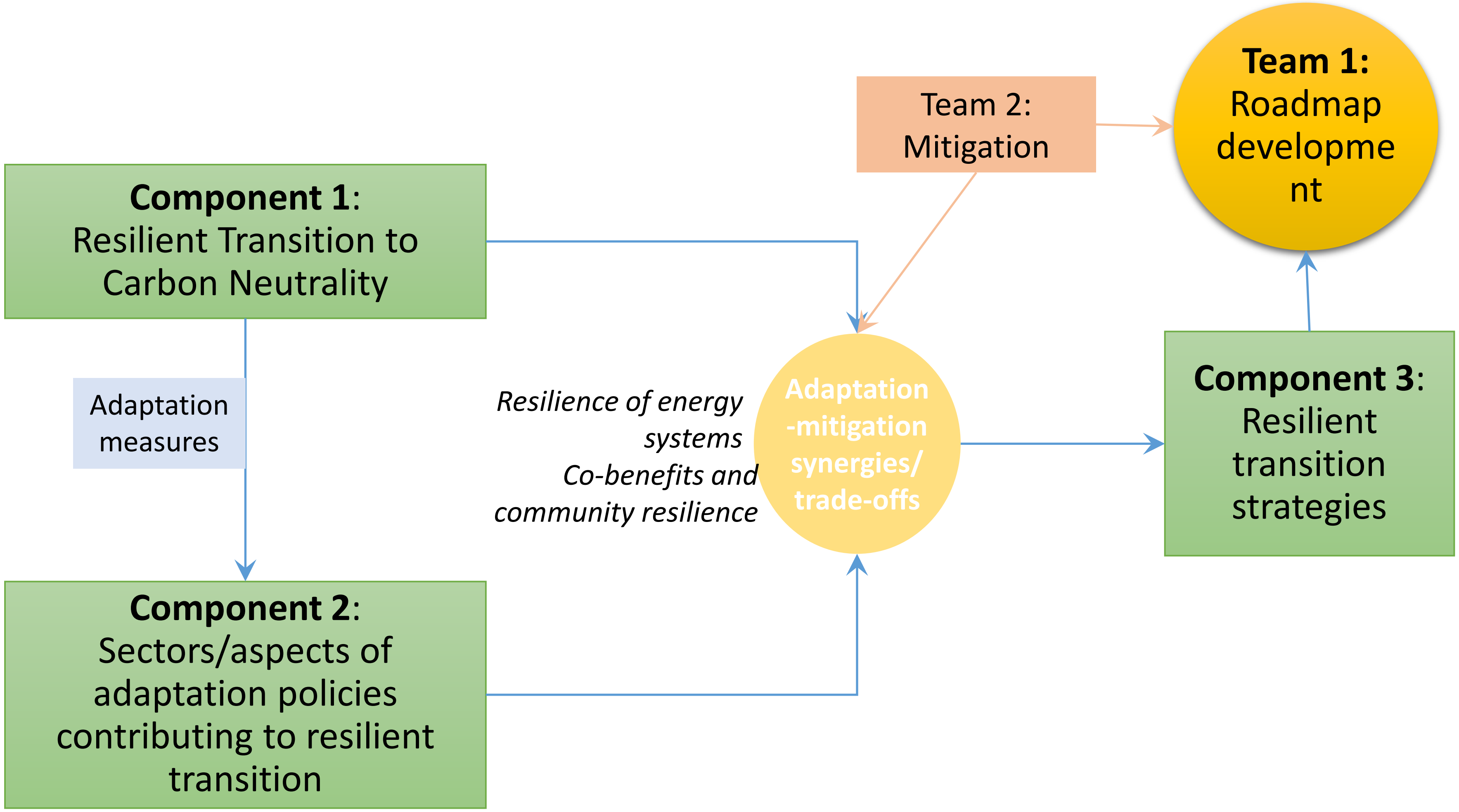
Overall outline of the research

How to transform into a ‘resilient’ net zero society where climate risks, including of the energy system, and the adoption of clean or renewable energy systems are integral to the transition?

Following mutually reinforcing areas have been identified for analyzing three components:

- Coherence with existing policies and actions.
- Addressing land-use trade-offs.
- Reducing risks to energy systems from climate impacts.
- Maximizing adaptation co-benefits from renewable energy deployment while minimizing potential greenhouse gas (GHG) emissions from future adaptation interventions.
- Conducive policy, institutional and legal arrangements.



Potential of agrivoltaics versus agroforestry

- Scenario analysis of agrivoltaics deployment on herbaceous croplands, considering competition with agroforestry (both suitable for shade-loving and shade-tolerant crops)
  - **“agrivoltaics anywhere” scenario**: Any existing herbaceous croplands usable for agrivoltaics.
  - **“environmentally-conscious agrivoltaics” scenario**: Agrivoltaics not permitted in environmentally sensitive areas (e.g., near protected areas, wetlands, forests, etc.).
- Assumption: Agroforestry provides more benefits to biodiversity/ ecosystem services in environmentally sensitive areas, so it should be prioritized in these areas.
  - E.g., trees remove pollutants from runoff, regulate water temperatures, provide corridors for wildlife.

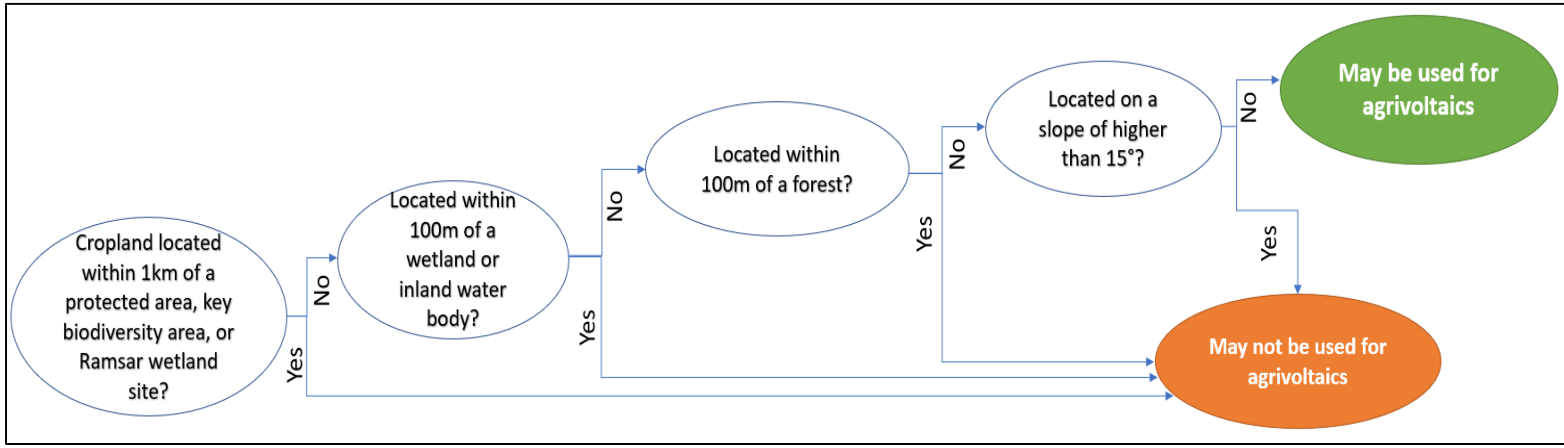
Example of agrivoltaics

Source: Chae et al. (2022)

Example of agroforestry

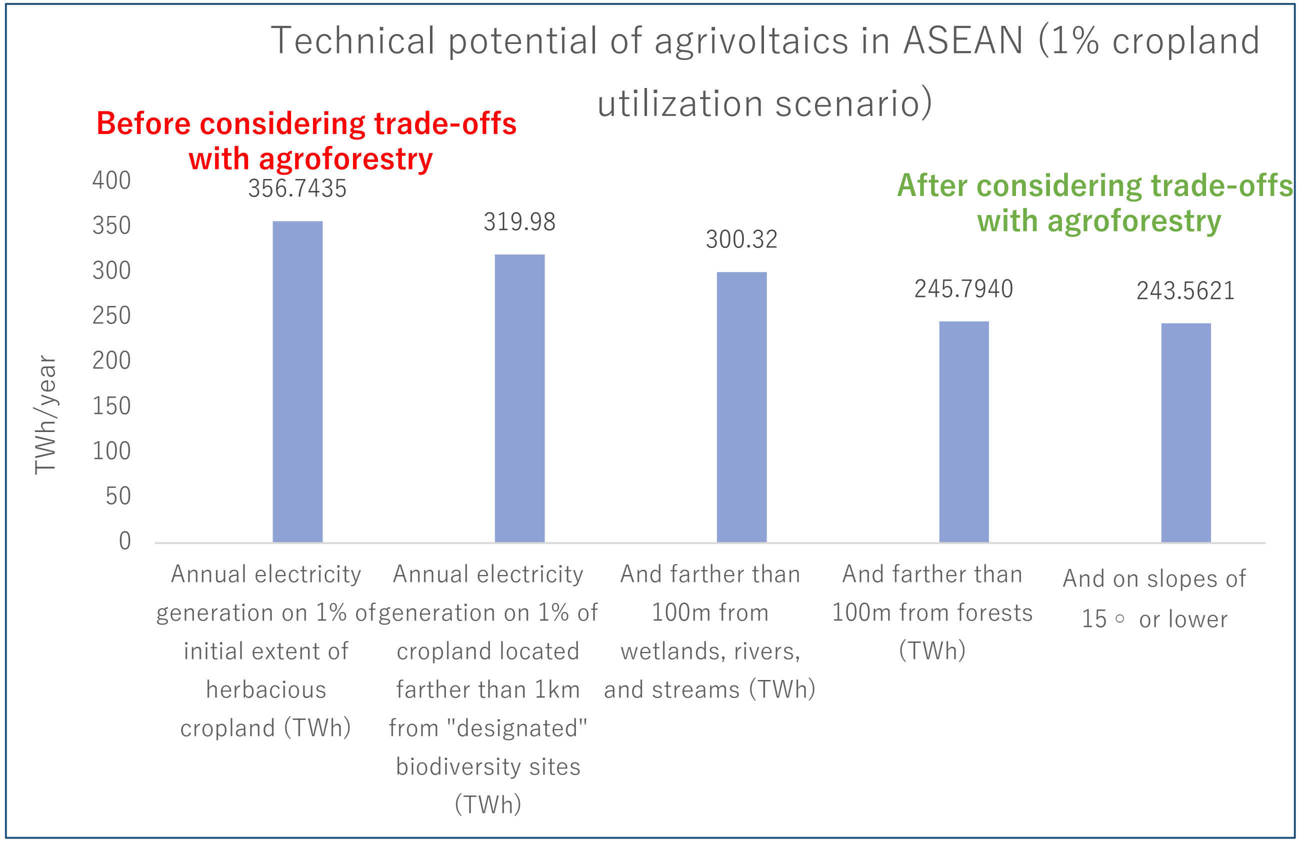
Source: Prof. Demi Macandog

Methodology overview (from Johnson et al., 2024)



Johnson, B. A., Arino, Y., Magcale-Macandog, D. B., Liu, X., & Yamanoshita, M. (2024). Potential of agrivoltaics in ASEAN considering a scenario where agroforestry expansion is also pursued. *Resources, Conservation and Recycling*, *209*, 107808.

Land-use trade-offs analysis: Results



Country	2020 (TWh)	2050, APAEC Target Scenario (APS) (TWh)	Agrivoltaics potential relative to electricity consumption in APS (1% of the allowable areas are used) (%)	Agrivoltaics potential relative to electricity consumption in APS (10% of the allowable areas are used) (%)
Brunei Darussalam	4.73	8.99	0.003%	0.03%
Cambodia	11.09	17.34	145%	1451%
Indonesia	**275.58**	**642.27**	**8%**	**76%**
Lao PDR	7.78	48.21	10%	104%
Malaysia	152.13	220.88	1%	7%
Myanmar	20.29	32.91	175%	1745%
Philippines	**83.24**	**231.65**	**5%**	**50%**
Singapore	50.78	67.76	0.0016%	0.016%
Thailand	**187.26**	**355.11**	**21%**	**206%**
Viet Nam	**218.02**	**483.16**	**5%**	**47%**
ASEAN Total	1010.91	2108.00	12%	117%

- Agrivoltaics can meet most projections of ASEAN's electricity generation needs by 2050 if 10% of the allowable areas are utilized.
- Expansion of agrivoltaics need not conflict with the expansion of agroforestry in environmentally sensitive areas.
- Agroforestry can be promoted on croplands in environmentally sensitive areas, and agrivoltaics in other areas.

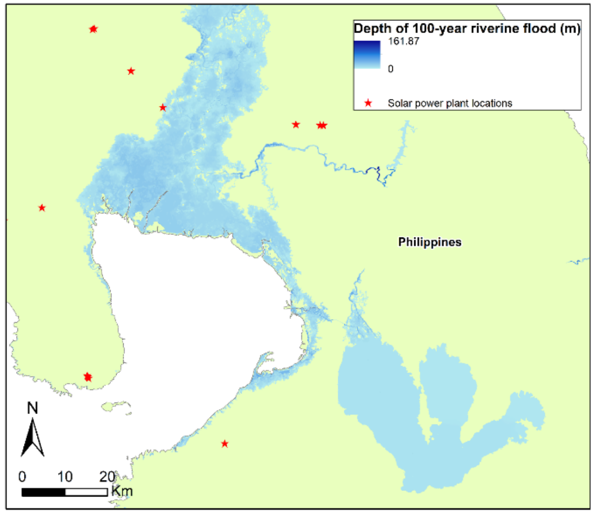
An Analysis of the relationship between flood hazards and the siting of existing utility-scale solar power plants in ASEAN

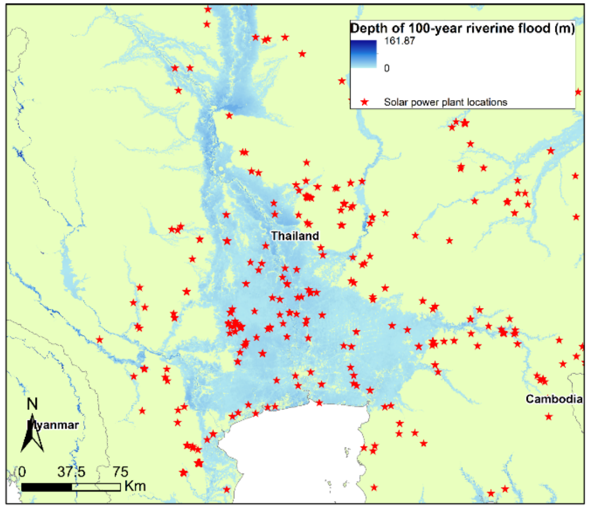
Impacts from extreme climate events such as storm surges, typhoons, floods, landslides and sea level rise have serious implications for the safe, reliable and affordable operation of energy system (IEA 2024).

Logistic regression modeling to see how flood hazard variables are related with solar power plant presence/absence

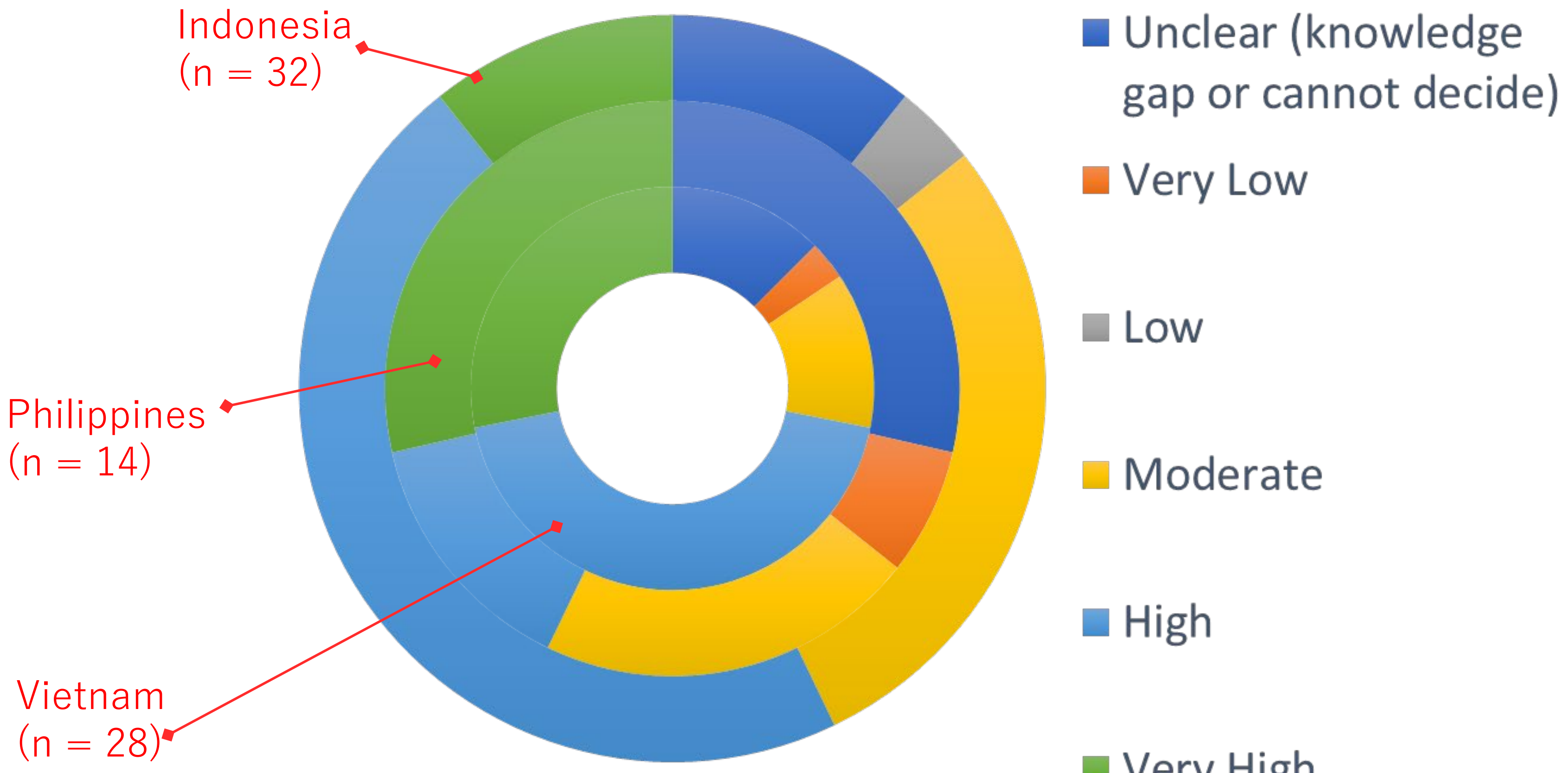
Independent variable	Standardized coefficient value	Standard error	Wald Chi-Square	Pr > Chi²
Global irradiation on a tilted surface	0.981	0.008	14287.02	<0.0001
Distance to nearest urban area (km)	-1.916	0.017	13236.98	<0.0001
Depth of 100-year return period river flood (m)	-0.123	0.007	355.60	<0.0001
Depth of 100-year return period coastal flood (m)	-0.034	0.005	46.76	0.001

Flood hazards a factor in deciding where to build solar power plants, even though less significant than other factors that affect profitability (solar irradiation, distance to urban areas)





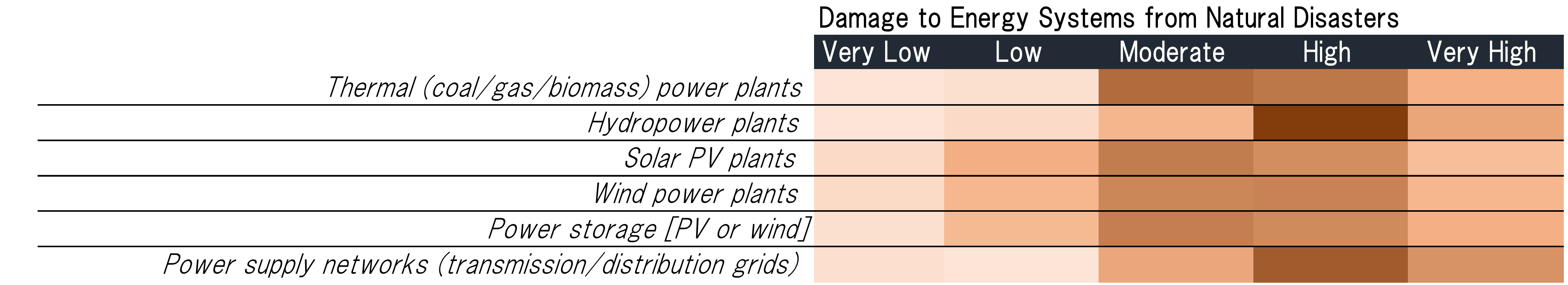
Overall risk to the energy system

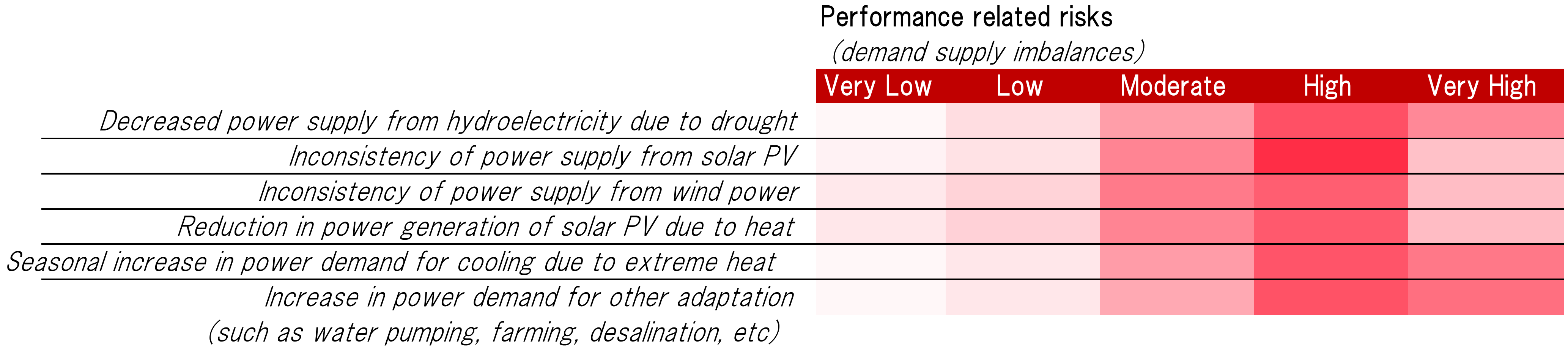


The results from the questionnaire survey shows moderate to very high level of risk to energy system

Resilience of energy system

We examined two aspects of energy system: damage to energy production, storage and supply; Performance





There is growing understanding on the risks to both energy supply and demand due to climate change impacts. The results from the questionnaire survey as well as recent energy crisis (such as due to drought in Vietnam and Philippines) asks for a sound strategy to climate-proof the current and future energy system

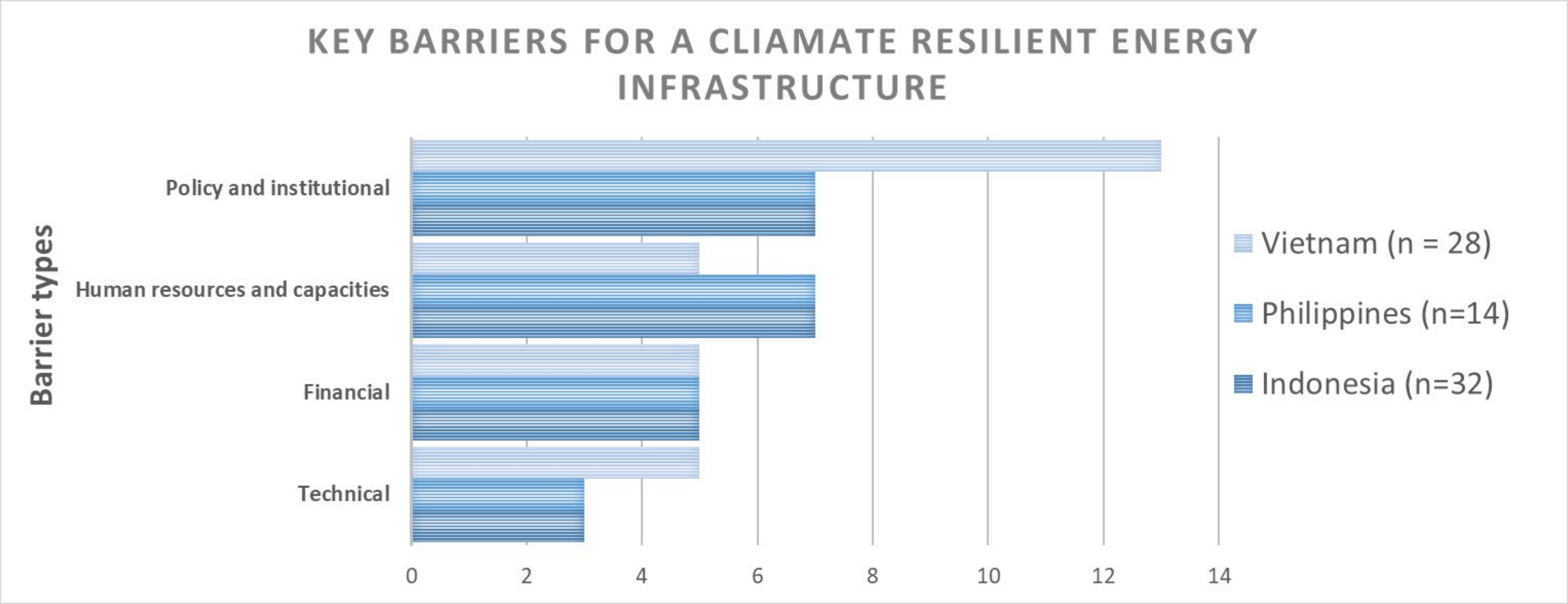
Resilience of Renewable Energy Systems

There is limited preparedness and inadequate safeguard/adaptation measures in place to protect energy systems. Available evidences and reports strongly suggests that resilience consideration of renewable energy systems is essential for future energy security and cost saving (Schaeffer et al. 2012; Gernaat et al. 2021; Jasiūnas, Lund, and Mikkola 2021; IEA 2024).

Countries	Identified climate risks to energy systems	Potential adaptation responses for resilience building
Indonesia	Water scarcity and impact to hydro-power capacity, cooling power plants, etc. Damage to energy infrastructure,	Climate proof renewable energy and infrastructure to facilitate investment in wind, solar radiation, hydro, geothermal and create opportunities for green jobs. Promote sustainable bio-energy industries
Philippines	Significant changes in energy demand due to fluctuations in temperature and weather condition (National CC Action Plan 2011-2028); Rising ambient temperatures will lead to higher energy use to cool buildings. Damage to energy infrastructure from disasters	Strengthen existing infrastructure facilities to adapt to and withstand adverse conditions and disruptive events Efficient restoration of energy supply in the aftermath of disruptive events Develop resiliency standards of energy systems
Thailand	Prevent risks of disruption to production and distribution of energy, though not directly linked to climate change impacts	Predictable energy production and supply Stable energy price
Vietnam	Increased air temperature leads to increased energy consumption from uses of cooling devices, especially, during heat waves. Increase temperature also increases load to power plants (cooling water, transmission lines, turbine efficiency) Reduced hydro-power capacity due to droughts Damage to transmission lines from disaster (storm, landslides) Increased energy demand for water pumping, desalination, etc.	Upgrading and renovation of power plants, power transmission stations, substations, power transmission line systems;

Barriers

But there are different barriers to overcome in order to tap the potential and reduce the risks.



While overcoming the barriers, we need strengthening and upscaling the share of decentralized renewables and phaseout and prevent new installations of negative energy technologies and system that leads to enhancement of GHG emission.

Harnessing adaptation co-benefits from renewables for livelihood resilience

Renewables are often considered a climate change mitigation measure, while their importance to climate change adaptation has been overlooked (Jeong and Ko 2021).

The transition to renewable energy not only reduces emissions but also contributes to climate adaptation and enhances climate resilience through diverse and decentralised energy solutions (REN21 2024).

Switching to renewable/low-carbon energy produces multiple co-benefits including improving access to electricity, enhancing energy security, providing local green jobs, reducing indoor and outdoor air pollution, and improving development potential (ASEAN 2021).

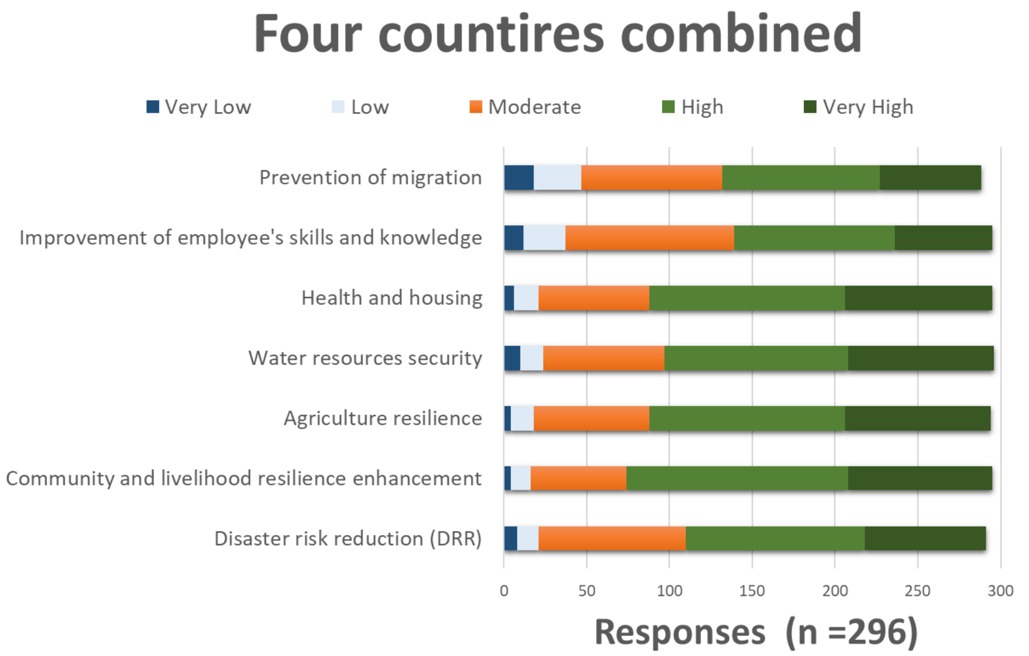
Renewable energy applications for adaptation and resilience (Adapted from (Jeong and Ko 2021; REN21 2024))

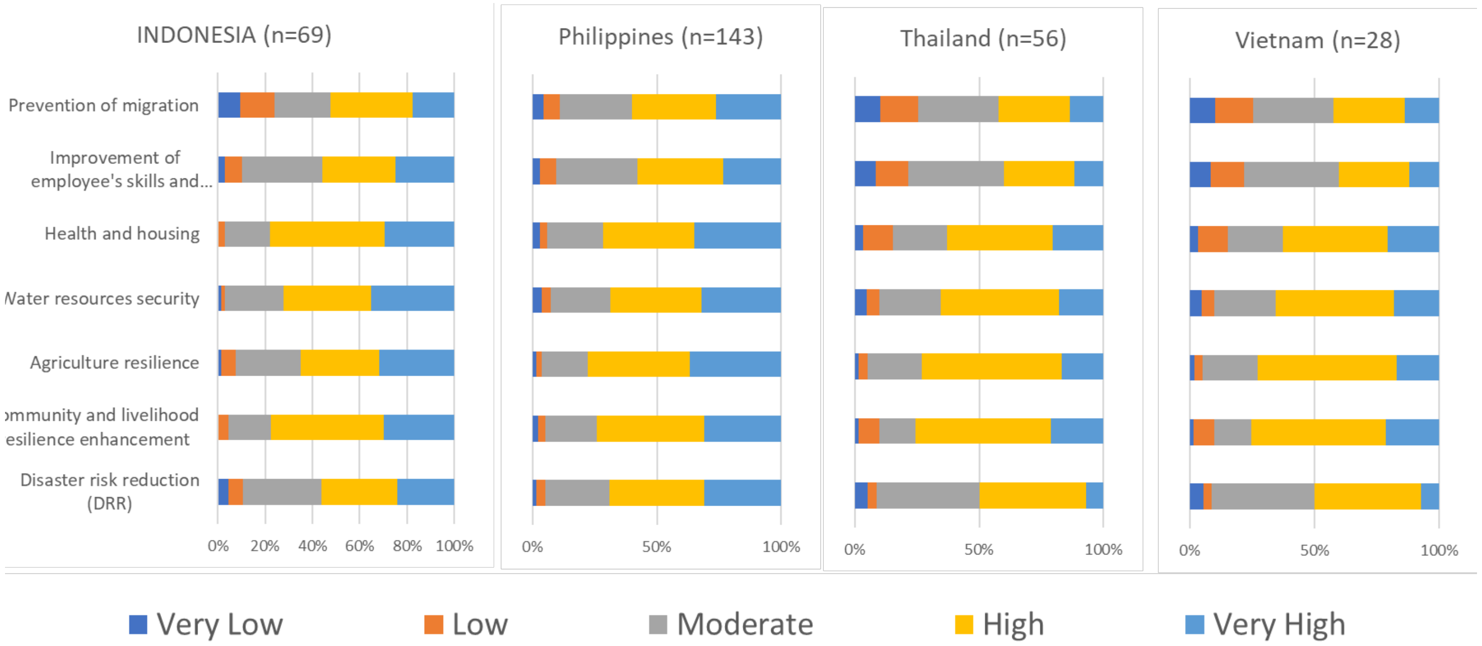
Climate impacts	Sectors/Areas	Applicable RE options
Water scarcity	Water storage/supply/ irrigation	Desalination using PV, including renewables-powered purification of groundwater in coastal areas affected by salt-water intrusion due to seal level rise Solar Pumps Floating solar panels in lakes and water reservoirs/dams to prevent evapotranspiration losses Solar panels over the irrigation canal to prevent evapotranspiration losses
	Wastewater treatment and sanitation	Biogas generation, water recycling, renewable energy-based water purification and sanitation systems
Temperature rise, heat wave, drought	Crop production	Solar irrigation, agrivoltaics for green house farming, vertical farming, solar panels for crop shading
	Food storage, processing, and supply	Renewable energy for refrigeration, cold storage
	Livestock	Energy to regulate indoor environment of livestock farms
	Health (heat stress, extreme cold)	Renewable energy for indoor heating/cooling/air conditioning, renewable energy for cooling heat stress shelters, renewable-powered emergency services and healthcare facilities
Fast-onset extreme events and natural disaster	Energy supply disruption	Decentralized renewable energy or renewable energy as energy back-up, renewables-powered mini- and microgrids for electricity supply, including in remote communities
	Communication service	Renewable energy for early warning, solar-powered portable chargers to keep communication devices operational,
	Evacuation centers	Renewable energy for heating and cooling
	Flooding and coastal erosion	Renewables-powered water pumps to manage water levels in coastal areas during floods and storm surge, hydropower plants and reservoirs for flood prevention
	Forced displacement	Decentralised off-grid electricity generation in disaster-hit regions and beyond

Harnessing adaptation co-benefits from renewables for livelihood resilience

Renewables offer an end-use-centric approach of just and inclusive energy transition for livelihoods, poverty alleviation and climate resilience. Decentralised renewables offer opportunities for local ownership, innovation and entrepreneurship in an effective manner, allowing tailored access at the grassroots level.

Adaptation co-benefits of the renewable energy system





Adaptation co-benefits well recognized in all four countries at the policy level or in practice

Results of questionnaire survey suggest moderate to very high level of adaptation co-benefits in 7 key areas

(Source: questionnaire survey)

Situations of laws and policies

	Philippines	Vietnam	Thailand	Indonesia
Relevant laws and regulations	• 2009 Climate Change Act • National Framework Strategy on Climate Change 2010-2022 • National Climate Change Action Plan 2011-2028	• Law on Environmental Protection • Resolution 24/NQ/TW (2013) on responding to climate change by Central Party Committee	Climate Change Master Plan (CCMP) 2015-2050	• Regulation 46/2008 National Council on Climate Change • The National Action Plan on Climate Change Adaptation
Policy documents on climate change	National Framework Strategy on Climate Change 2010-2022 National Climate Change Action Plan 2011-2028 Philippine Strategy on Climate Change Adaptation 2010-2022	National Climate Change Strategy (2011) National Target Program to Respond to Climate Change (2013-2015)(2008-2012) National Action Program on Climate Change (2012-2020) Action Plan Framework for Adaptation and Mitigation of CC in the Agriculture and Rural Development Sector Period (2008-2020)	Climate Change Master Plan (CCMP) 2015-2050 National Strategy on Climate Change (2008-2012) Thailand Adaptation Plan	The National Action Plan on Climate Change Adaptation (RAN-API) National Action Plan on Climate Change Climate Change Sectoral Roadmap
Competent authority	• Climate Change Commission (Office of the President) • Climate Change Office in the Department of Environment and Natural Resources	• Government National Climate Change Committee • National Steering Committee for the implementation of UNFCCC and Kyoto Protocol	• National Committee on Climate Change (chaired by Prime Minister) • Ministry of Natural Resources and Environment	• National Council on Climate Change

The assessment of current policy approaches

Each country calls for the integration of mitigation and adaption, mostly under the overall development strategies, **concrete policy mechanisms or measures for coordination do not exist.**

Indonesia	In Visi Indonesia 2045, mitigation and adaptation are positioned as part of development policy and are oriented toward integrated efforts. The basic strategies of climate policy include a landscape approach that emphasizes ecosystems and a particular emphasis on food, water, and energy resilience. However, it does not present principles to coordinate mitigation and adaptation in policy terms.
Philippines	Under the 2010 National Framework Strategy on Climate Change (NFSCC), the basic policy guiding principle was the primacy of adaptation over mitigation. There are no updates to basic policies after the Paris Agreement.
Vietnam	There are no elements related to adaptation considerations in decarbonization. Individually, the NAP description analyzes the impacts of climate change on the energy sector. However, this is only an individual reference in one sector and does not represent a principle or approach to coordinate mitigation and adaptation.
Thailand	Mitigation and adaptation were treated as independent policy areas, and no opportunity for coordination between the two was found. Policies of mitigation and adaptation are created within relatively independent policy processes.

(Source: questionnaire survey)

Overall recommendations targeting better policy and institutions

- Under the Paris Agreement, mitigation (NDCs) and adaptation (NAPs and NDCs) are treated as separate and independent issues. **It would be desirable to come up with concrete coordination mechanisms for efficient uses of funds, resources and capacities.**

- The government policies/pledges on net zero transition or adaptation plans (such as NAPs) are already backing synergistic climate action that not only addresses adaptation but also mitigation, disaster risk reduction, SDGs, biodiversity, etc. Gap remains on 'how the policy aspirations and adaptation/mitigation plans are translated into actions at scales', 'how resources and enabling conditions are met for their implementation', and 'how targeted outcomes are set and evaluated'.

- It would be good to capitalize on emerging understanding on climate risks to renewable energy system harnessing adaptation co-benefits while addressing land-use trade-offs.

- All countries have certain ministry/division to oversee both mitigation and adaptation policies. We should first recognize that there may be trade-offs or areas of incompatibility between mitigation and adaptation policies, and then **give mandates to appropriate organs to conduct such assessments**.

- Finally, the basic aim of the 'resilient' net zero roadmap will be to facilitate effective mobilization of available resources that works towards creating an energy system that is clean, resilient, reliable, and affordable while generating adaptation and resilience benefits and creating socio-economic opportunity such as green jobs for people.

Thank you for your kind attention!!