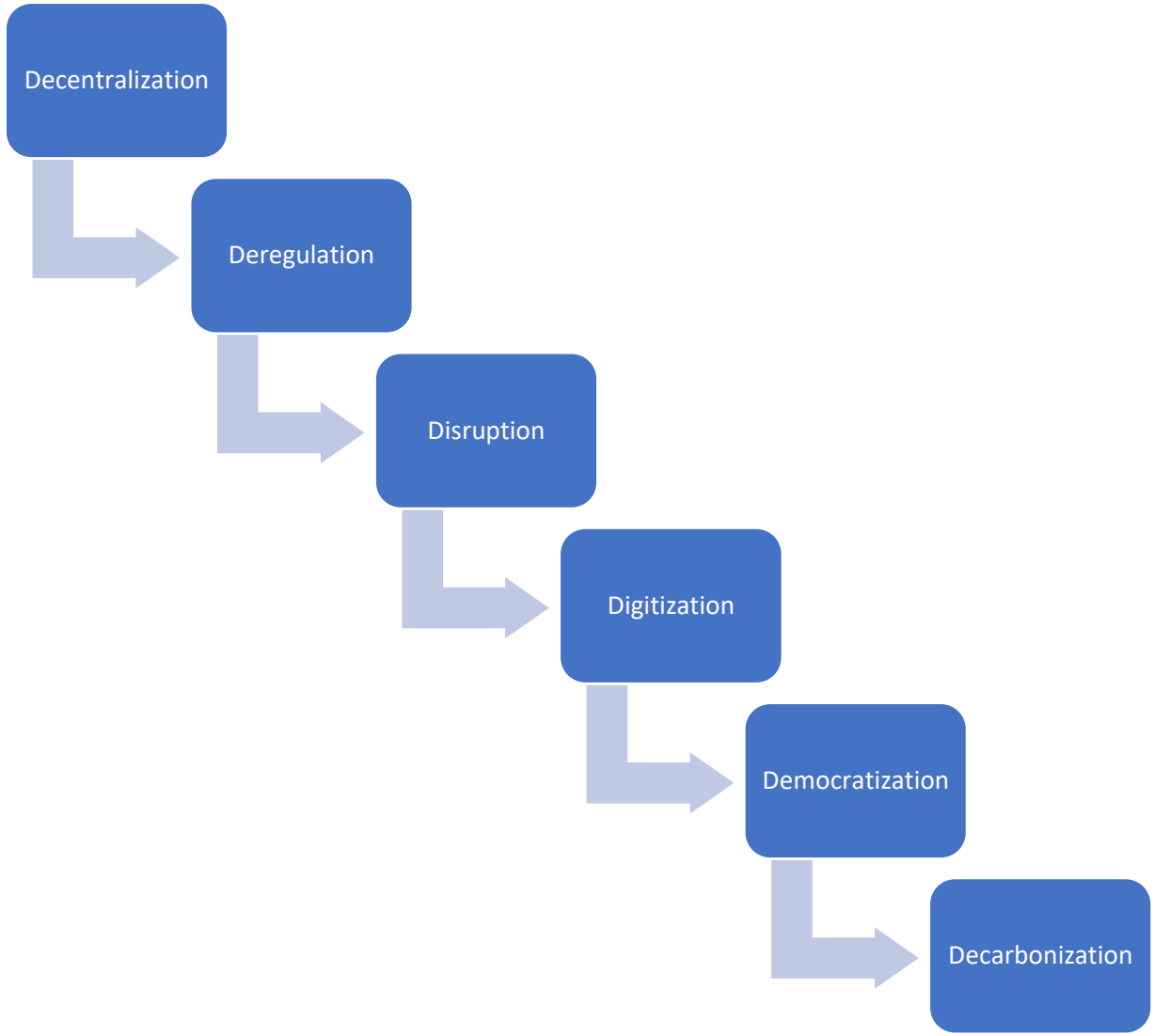
# Opportunities for renewable energy technology investments in Davao Region

Dr. Nelson H. Enano, Jr.

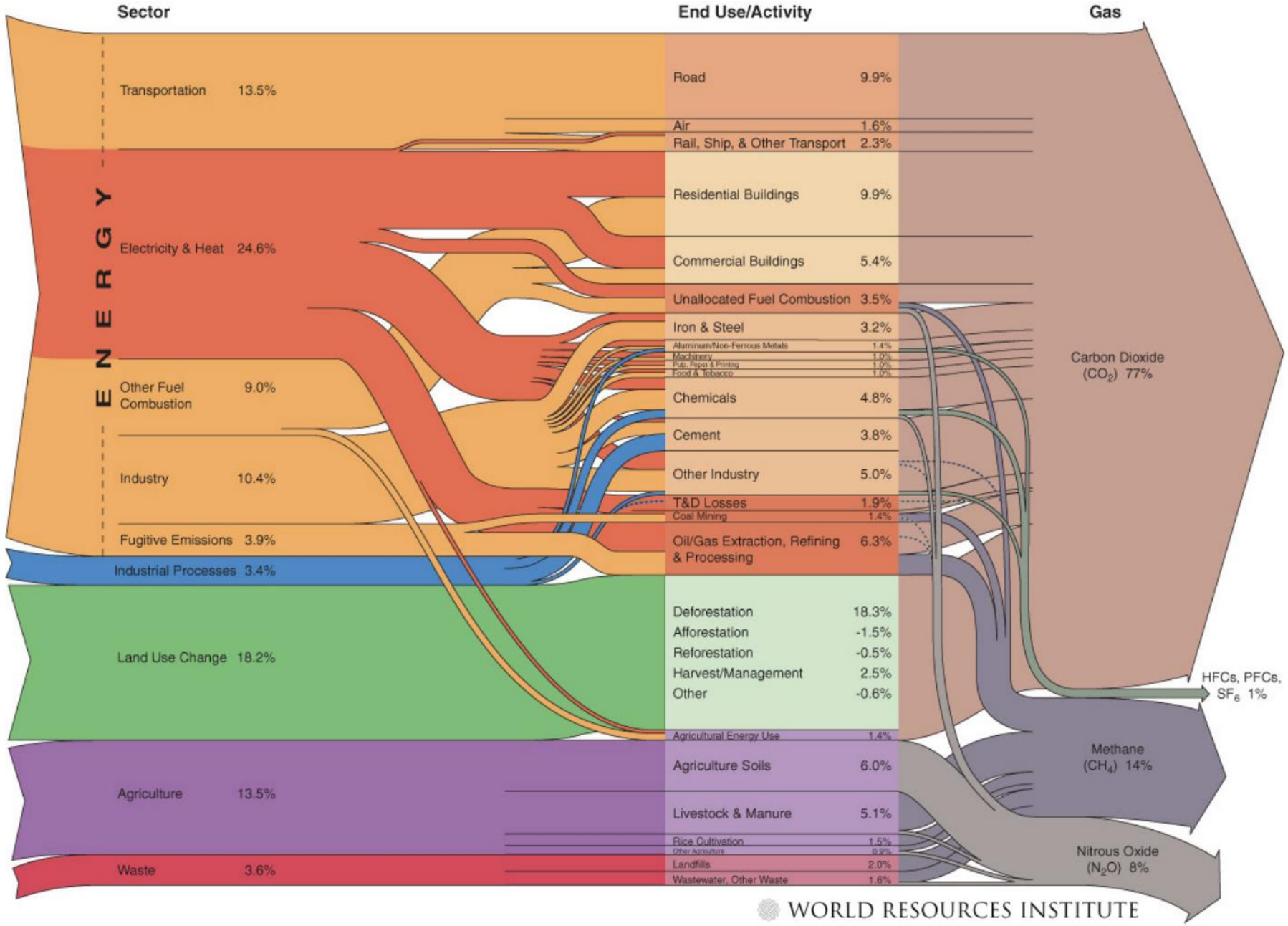
Director, Center for Renewable Energy and Appropriate Technologies

Ateneo de Davao University

# 6Ds of Future Energy Systems

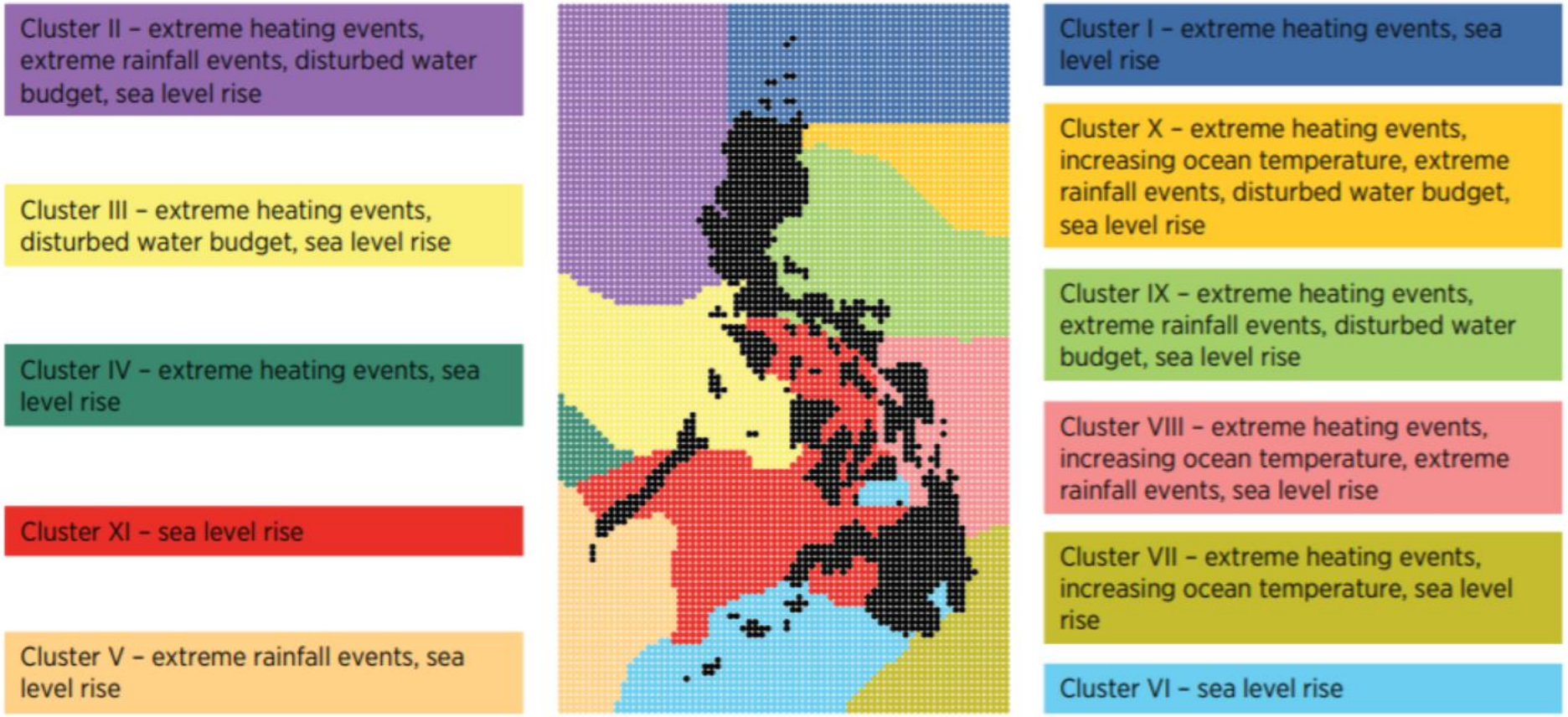


# World GHG Emissions Flow Chart




WORLD RESOURCES INSTITUTE

# Philippine exposure to climate change




Source: Philippine Department of Environment and Natural Resources, 2013

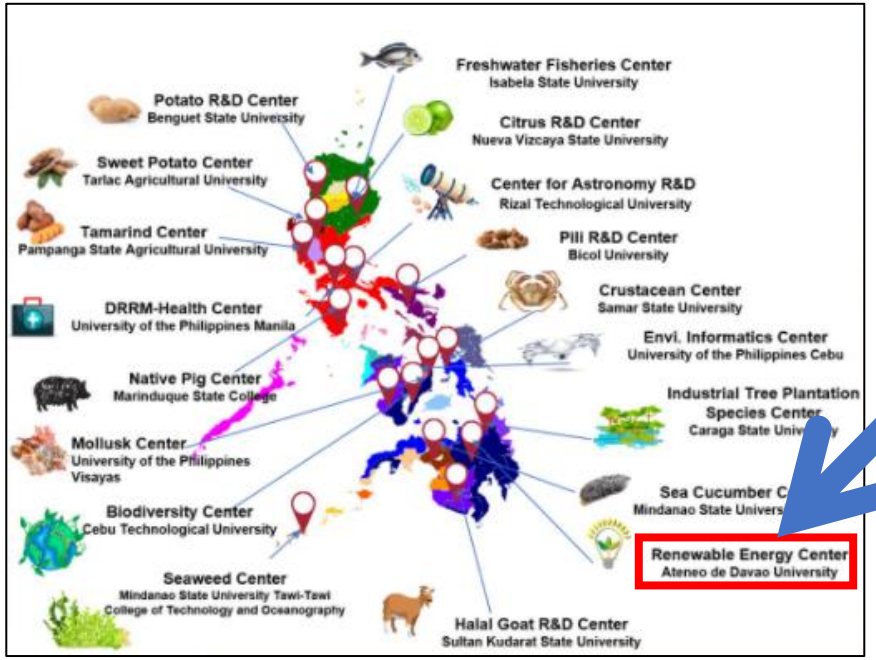
# Ateneo de Davao University

- Has a recognized R&D center on renewable energy since 2011, namely Center for Renewable Energy and Appropriate Technologies (AdDU-CREATE)
- A pioneer in the country in the installation of solar PV facility. The university has a total of around 1 MWp installed capacity.
- Has track record of researches in the area of energy harvesting technologies (primarily solar, wind, hydro, bio), missionary electrification, and energy policy
- DOST funded AdDU-CREATE to become the Mindanao Renewable Energy R&D Center (MREC) with focused research on ocean energy and concentrated solar power

Niche Centers in the Regions for R&D

NICER

To accelerate industrial competitiveness and R&D capacity building in the regions




(DOST, 2020)

FORTES-IN-FIDE ATENEO DE DAVAO

Ateneo CREATE

Center for Renewable Energy and Appropriate Technologies

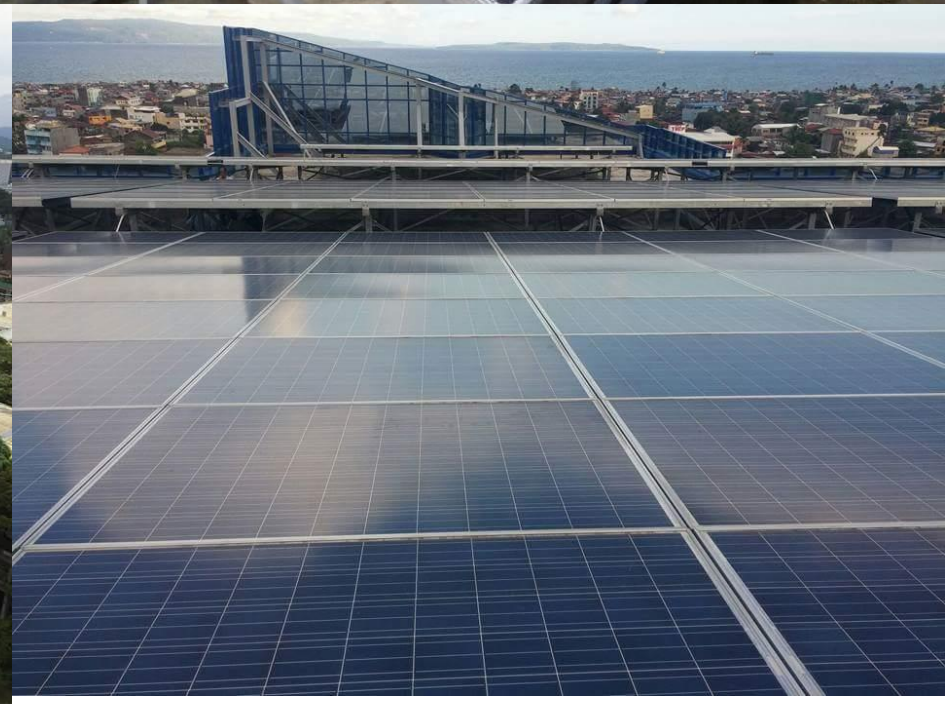
MREC

MINDANAO RENEWABLE ENERGY R&D CENTER


ADDU Academic Programs on Renewable Energy:

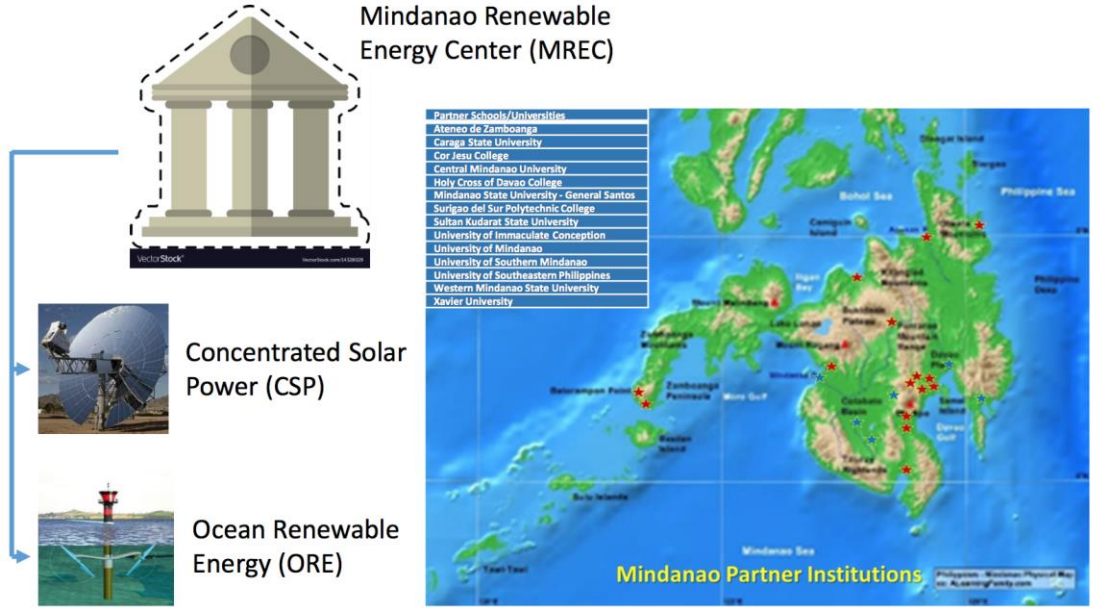
- ADDALL on Solar Power Technology
- Masters and Doctoral Programs on Renewable Energy

# Grid interactive Photovoltaic System

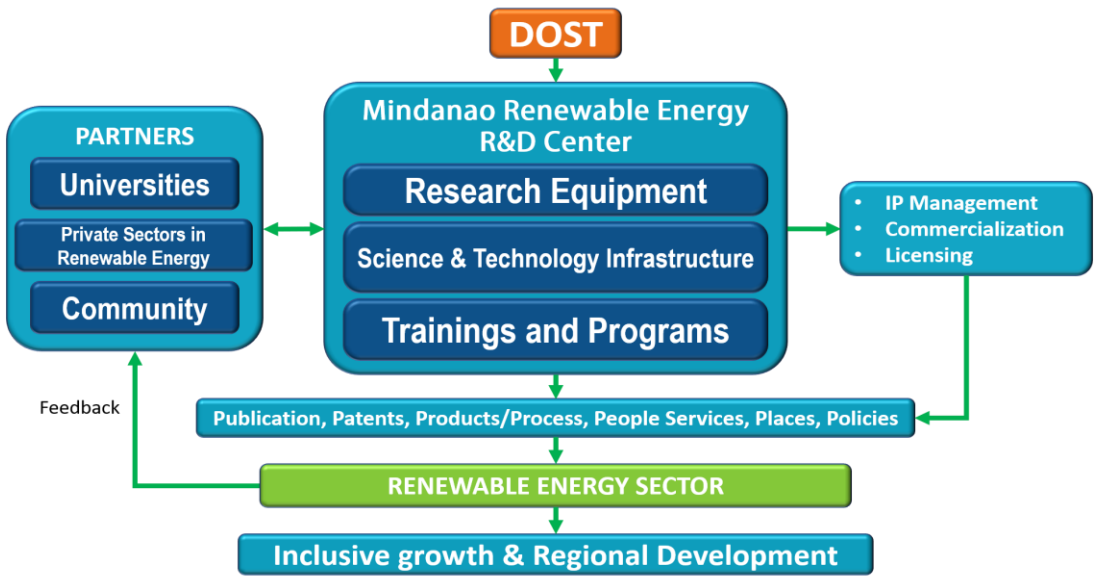


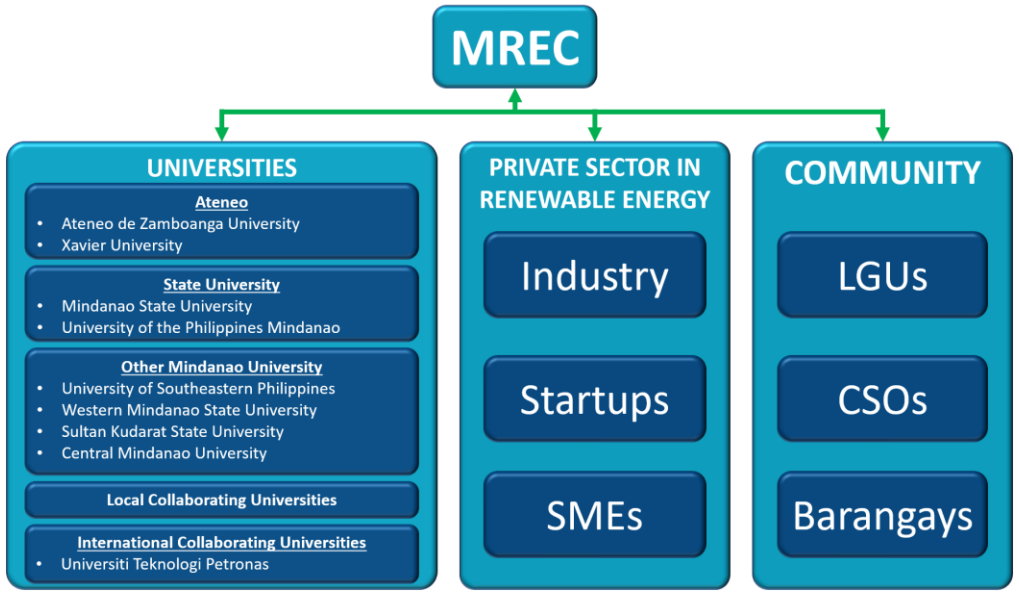

# Grid interactive Photovoltaic System with solar tracker


Wind
(NICER:
CPU)
ORE
Solar PV
CSP
Biomass
Biofuel
Hydro
(Micro/Pico)
NICER: URS
Productive
Utilization of Energy
(e.g., desalination,
Electromobility)
PMSG
Storage
NICER:
TIP/UP
Diliman
Energy
Markets and
Policy
MREC


Mindanao Renewable
Energy Center (MREC)
Concentrated Solar
Power (CSP)
Ocean Renewable
Energy (ORE)
Partner Schools/Universities
Ateneo de Zamboanga
Caraga State University
Cor Jesu College
Central Mindanao University
Holy Cross of Davao College
Mindanao State University - General Santos
Surigao del Sur Polytechnic College
Sultan Kudarat State University
University of Immaculate Conception
University of Mindanao
University of Southern Mindanao
University of Southeastern Philippines
Western Mindanao State University
Xavier University
Mindanao Partner Institutions

# Renewable Energy Ecosystem Framework



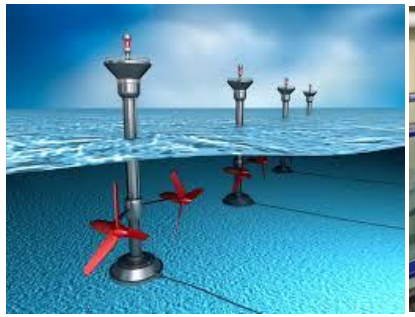
# MREC Program:
# Emerging renewable energy technologies

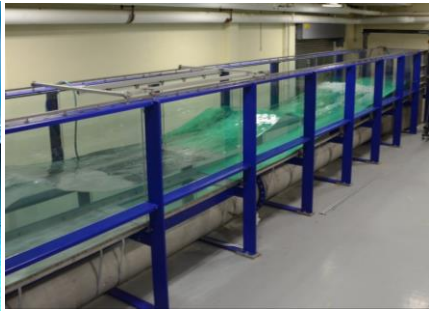
**Concentrated Solar Power (CSP)**

- CSP project aims to design, develop, and investigate a working steam power station for electricity generation and process heating purposes using PDS

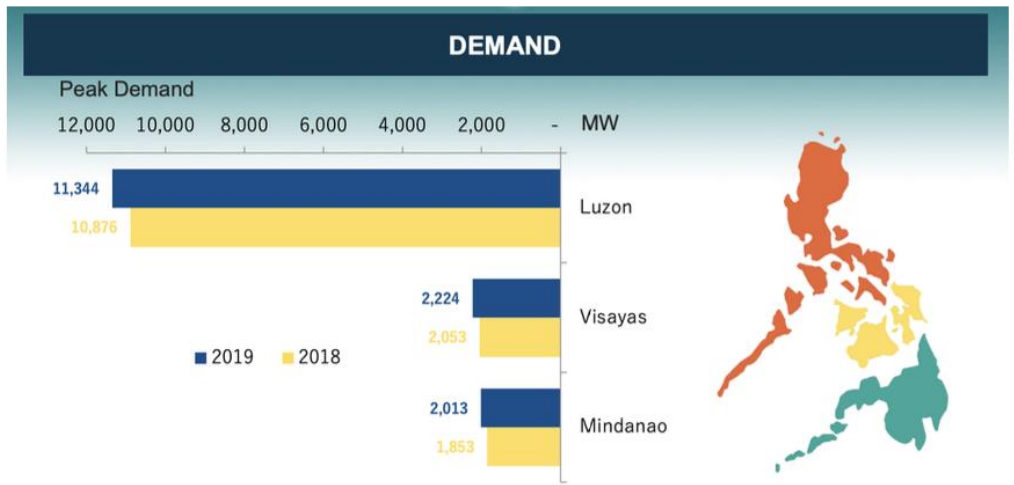
**Ocean Renewable Energy (ORE)**

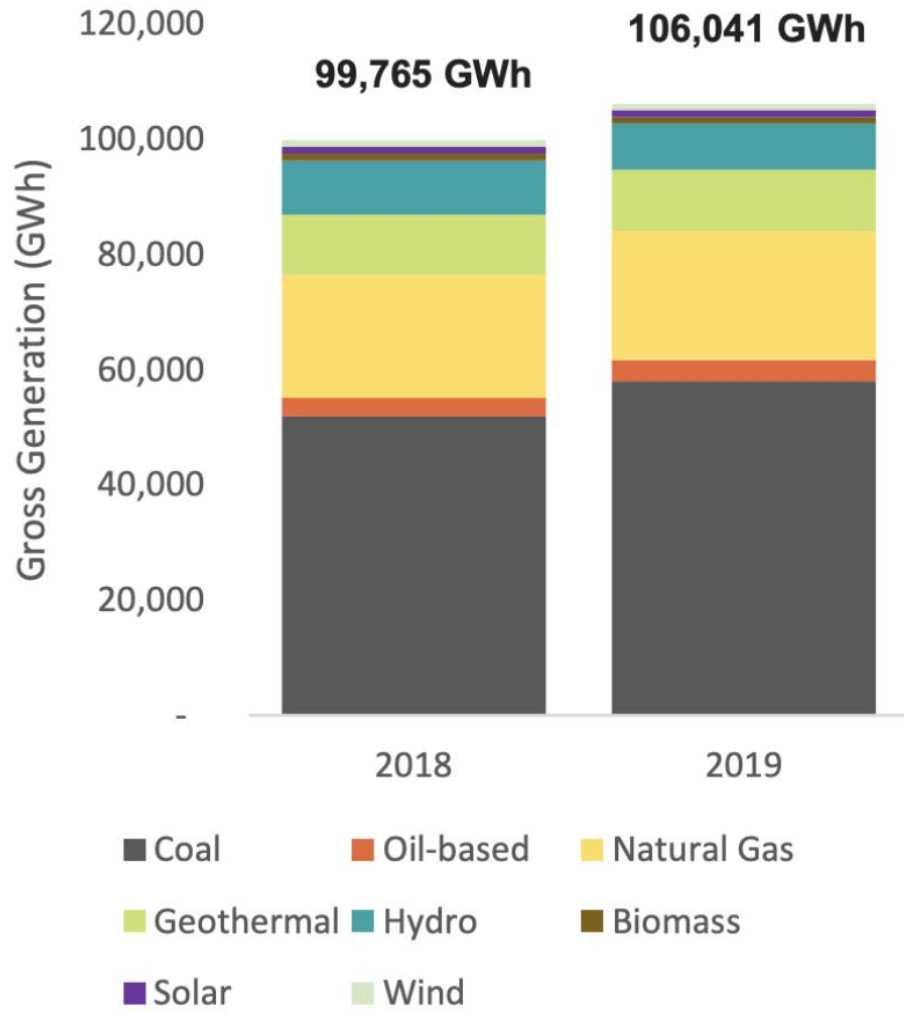
- ORE project aims to design, develop and investigate a working floating marine integrated renewable energy system for electricity generation.



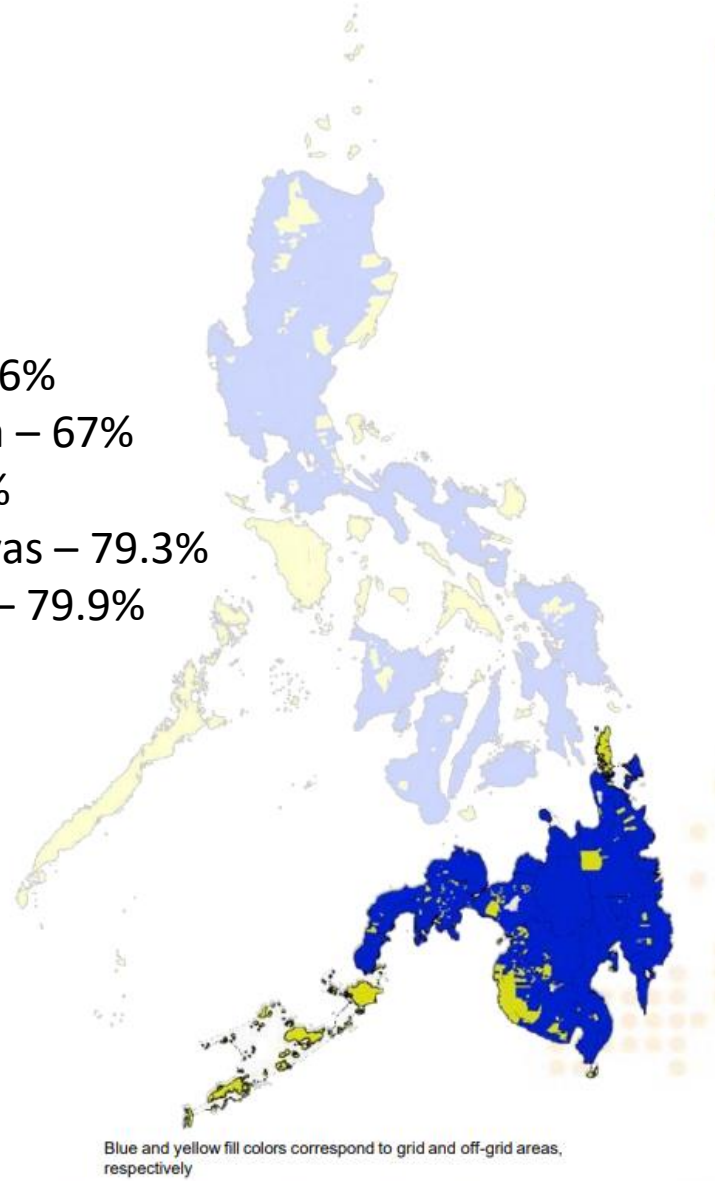


MREC
MINDANAO RENEWABLE ENERGY R&D CENTER


DEMAND
Peak Demand
12,000 10,000 8,000 6,000 4,000 2,000 - MW
11,344
10,876
Luzon
2,224
2,053
Visayas
2019 2018
2,013
1,853
Mindanao


120,000
100,000
80,000
60,000
40,000
20,000
-
Gross Generation (GWh)
99,765 GWh
106,041 GWh
2018
2019
Coal
Oil-based
Natural Gas
Geothermal
Hydro
Biomass
Solar
Wind

BARMM – 27.4%
SOCCSKSARGEN – 65.6%
Zamboanga Peninsula – 67%
Davao Region – 68.2%
Negros Island in Visayas – 79.3%
MIMAROPA in Luzon – 79.9%



Blue and yellow fill colors correspond to grid and off-grid areas, respectively

**2,013 MW**
Peak Demand
(8 May 2019)

**4,436 MW**
Installed Capacity

**3,832 MW**
Dependable Capacity

**13,805 GWh**
Gross Generation

68% Coal
0% Nat Gas
28% RE
4% Oil-based

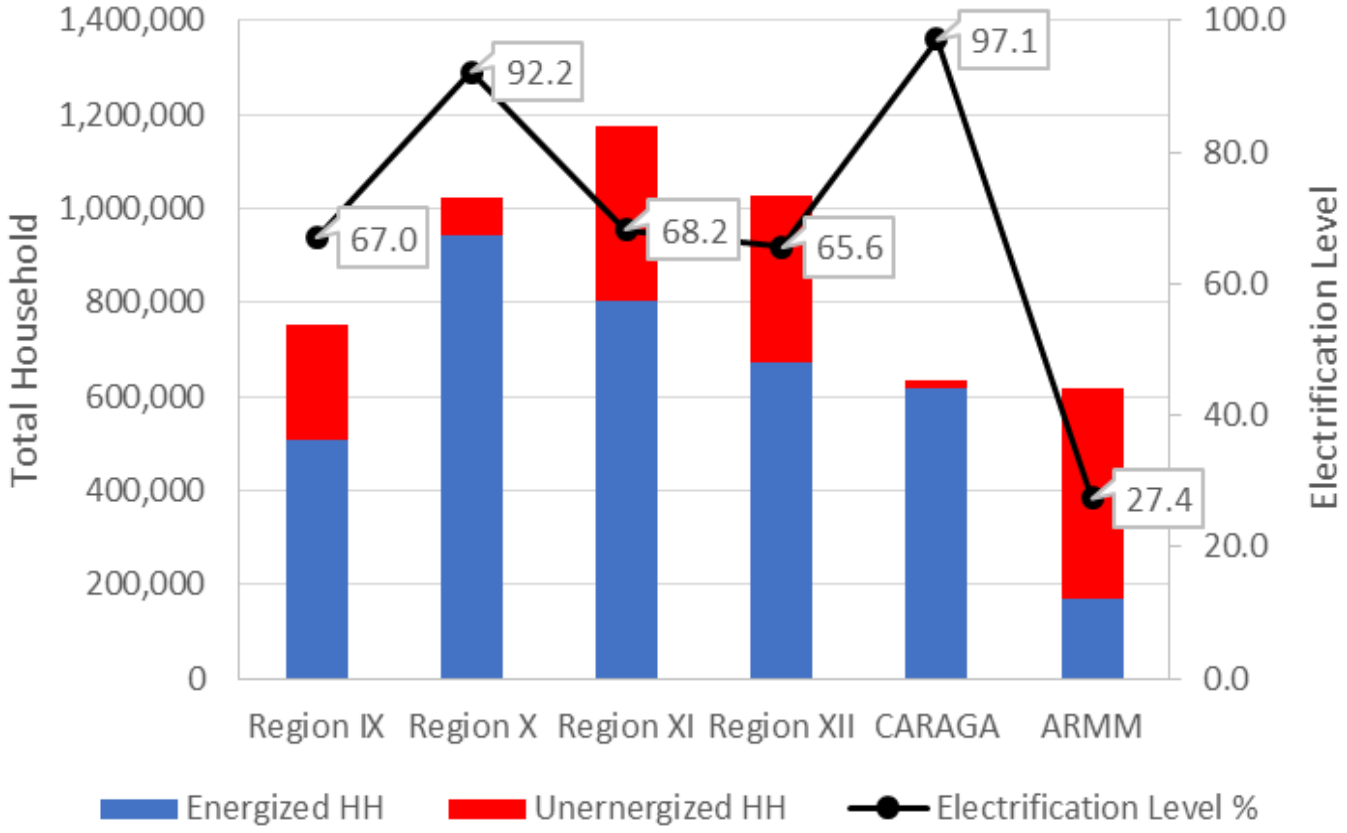
Electricity Sales and Consumption
**13,805 GWh**


**602 MW**
Newly Installed Capacity

**Power Projects**
589 MW - Committed
2,771 MW - Indicative

High SAIDI and SAIFI
One of the highest electricity tariffs in Asia

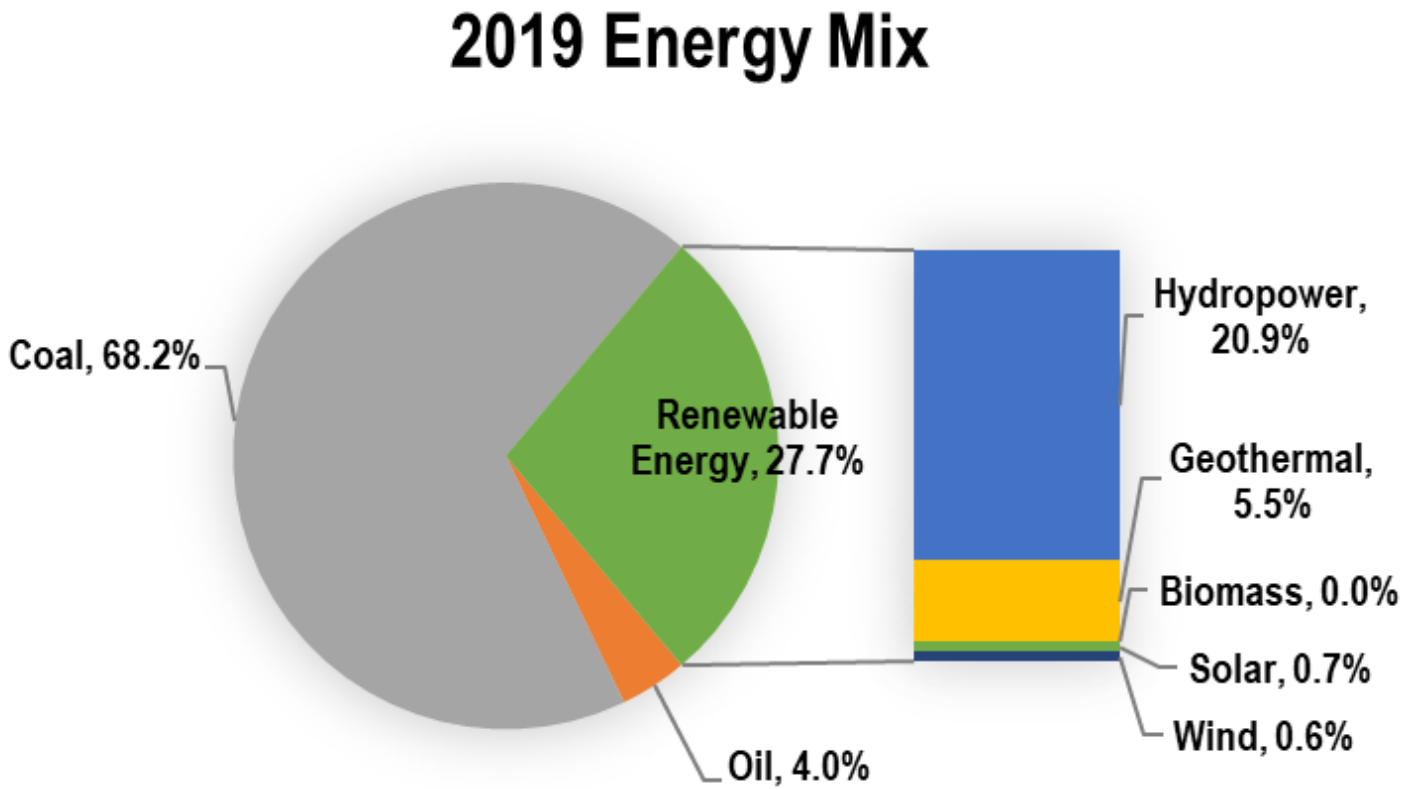
# Electrification in Mindanao



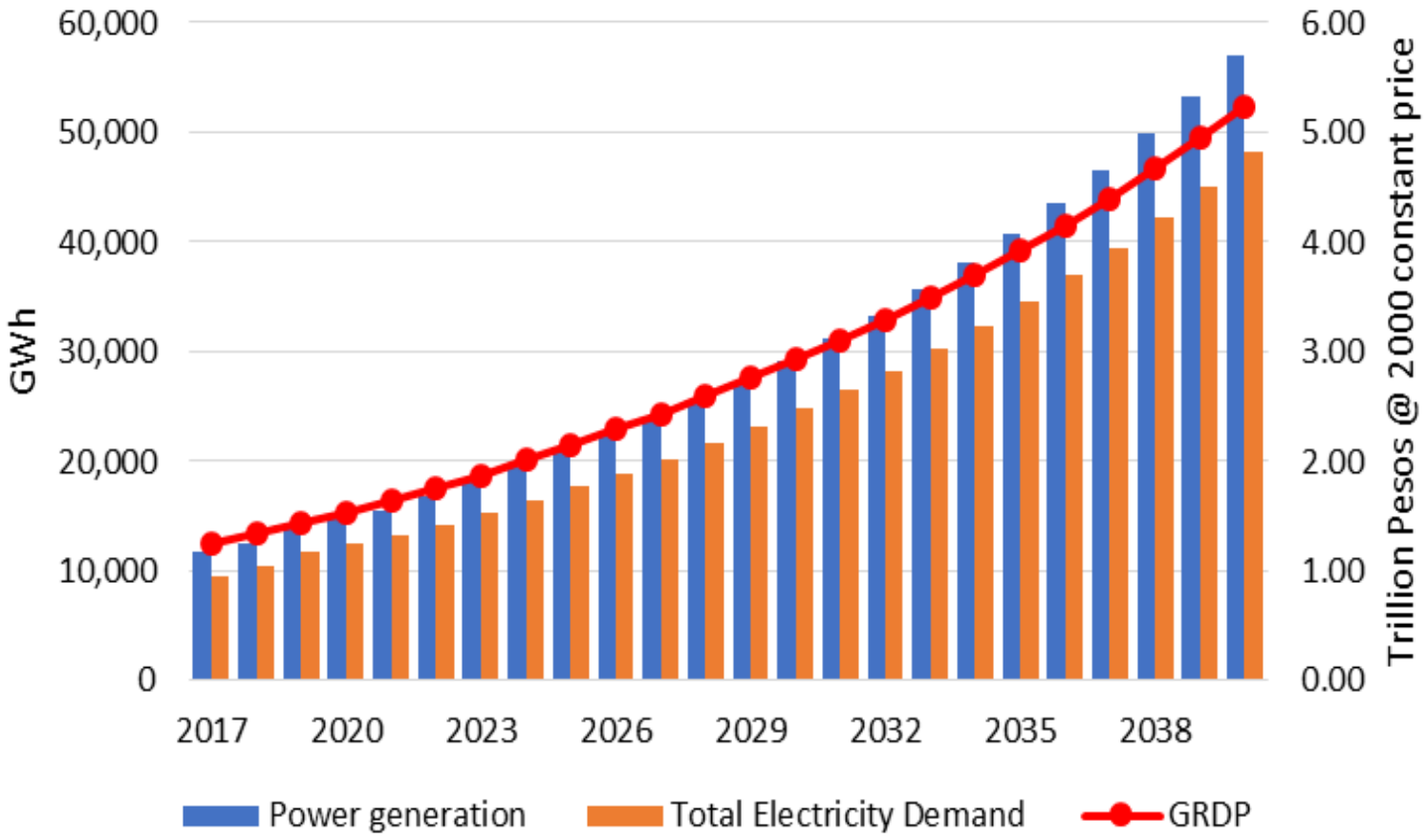

- According to a 2019 report, the government is planning to provide electricity all throughout the Philippines.
- As of 2017, Mindanao only has 70.9% of its households to have electricity with ARMM to have the least with only 27.4% (169,190 out of 618,600).

Department of Energy. (n.d.). *Mindanao Energy Plan 2018-2040.* Retrieved from https://www.doe.gov.ph/sites/default/files/pdf/pep/mindanao_energy_plan_2018-2040_updated.pdf

# Mindanao Energy Mix



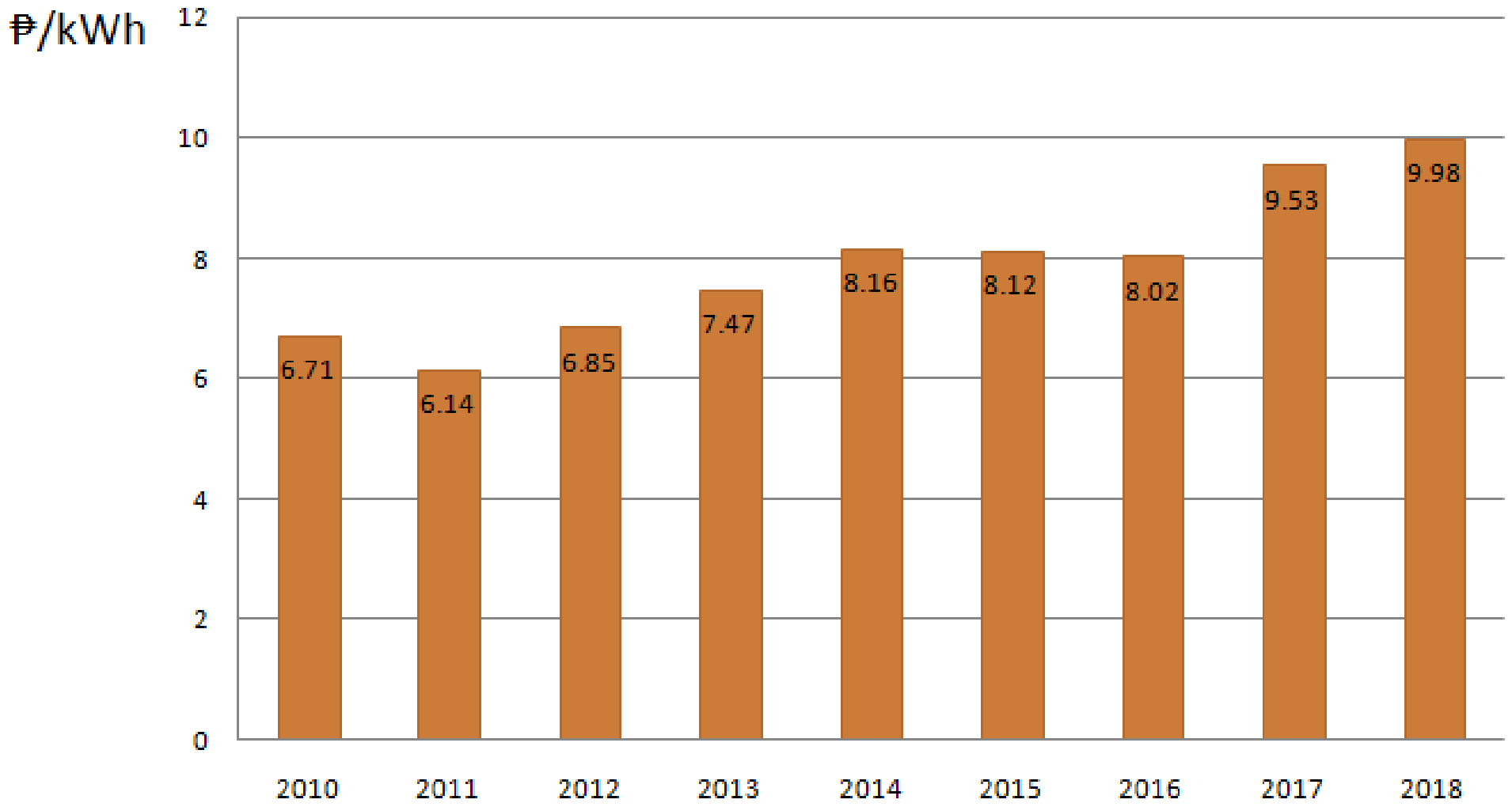
# Mindanao Energy Demand and Economic Growth




- Mindanao GDP Share has gradually rise from 14.36% (2016) to 14.52% (2018)
- Mindanao's growing economy will also increase electricity demand.
- Mindanao is projected to have a total electricity demand of 48,252 GWh by 2040 which requires a growth rate of 7.3% from 2017.
- Power generation is projected to reach 57,019 MW by 2040 which requires a growth rate of 7.1% from 2017

Department of Energy. (n.d.). *Mindanao Energy Plan 2018-2040.* Retrieved from https://www.doe.gov.ph/sites/default/files/pdf/pep/mindanao_energy_plan_2018-2040_updated.pdf

# Historical Average Electricity Rates in Mindanao

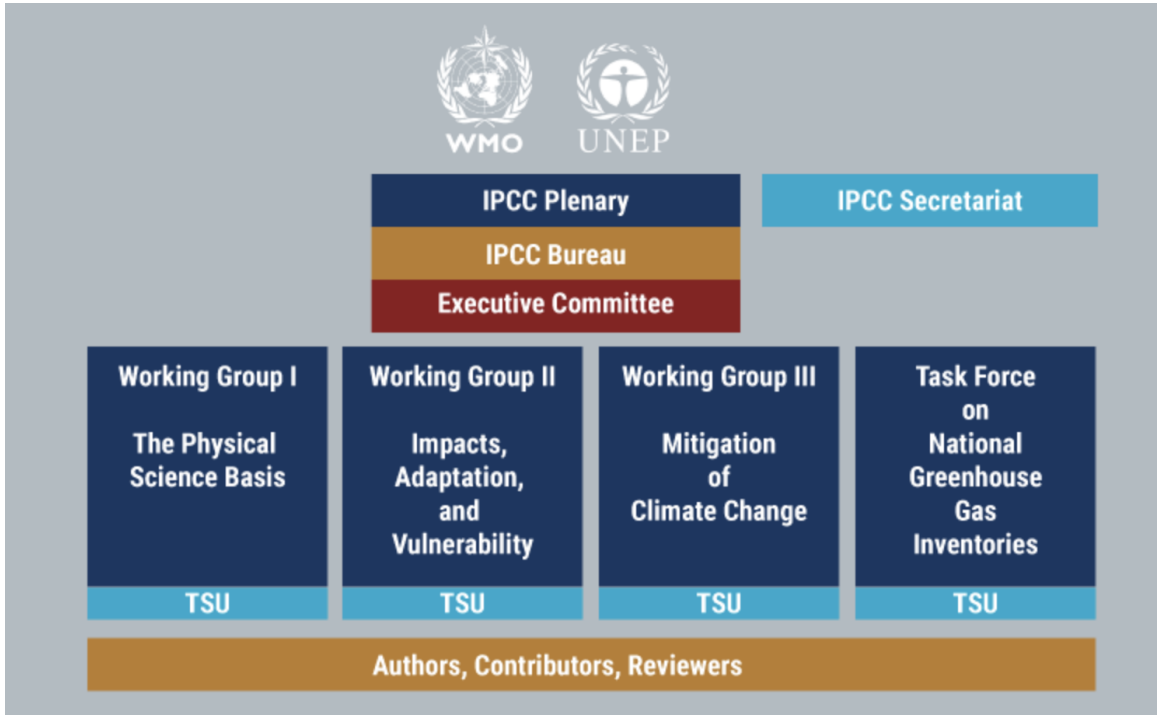



**Electricity Rate has an average increase of 3% increase annually**

# Nationally Determined Contribution (NDC)

- The Philippines promises to cut down its GHG emissions by 75% from 2020 to 2030 compared to the business-as-usual scenario of that same time period.

- Only 2.71% of this is an unconditional target, meaning the government commits to make this reduction using its own resources, with or without external aid. The remaining 72.29% reduction would only be met if the Philippines is provided assistance from the international community.



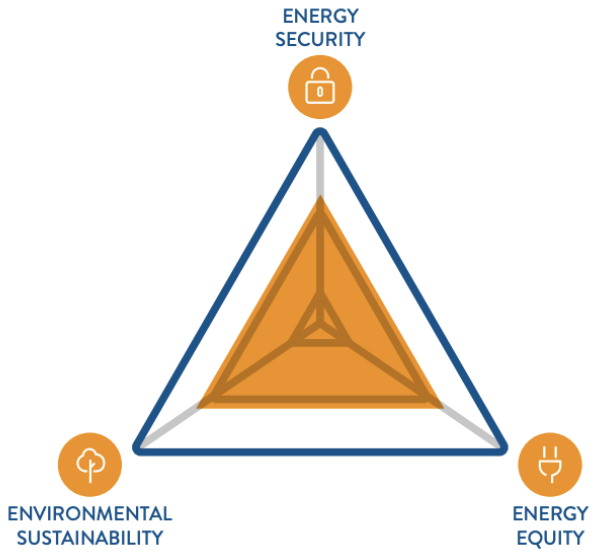

| PHILIPPINES | Main pledges and targets | |
|---|---|---|
| PARIS AGREEMENT | Ratified | Yes |
| | 2030 conditional target(s) | 70% below BAU by 2030<br>[1-14% above 1990 excl. LULUCF]<br>[32-40% below 2010 by 2030 excl. LULUCF] |
| | Coverage | Economy-wide, incl. LULUCF |
| LONG-TERM GOAL(S) | Long-term goal(s) | None |

# Sustainability index for energy

**ENERGY SECURITY**
Reflects a nation's capacity to meet current and future energy demand reliably, withstand and bounce back swiftly from system shocks with minimal disruption to supplies.

**ENERGY EQUITY**
Assesses a country's ability to provide universal access to affordable, fairly priced and abundant energy for domestic and commercial use.

**ENVIRONMENTAL SUSTAINABILITY OF ENERGY SYSTEMS**
Represents the transition of a country's energy system towards mitigating and avoiding potential environmental harm and climate change impacts.




## 2019

**TOP 10 ENERGY SECURITY**

1. Sweden
2. Denmark
3. Finland
4. Latvia
5. Canada
6. Angola
7. Ukraine
8. Romania
9. Slovenia
10. Czech Republic

**TOP 10 ENERGY EQUITY**

1. Luxembourg
2. Bahrain
3. Qatar
4. Kuwait
5. United Arab Emirates
6. Oman
7. Saudi Arabia
8. Netherlands
9. Iceland
10. Singapore

**TOP 10 ENVIRONMENTAL SUSTAINABILITY**

1. Switzerland
2. Denmark
3. Sweden
4. France
5. Norway
6. United Kingdom
7. Costa Rica
8. Luxembourg
9. Namibia
10. Slovakia

## 2017

**TOP 10 ENERGY SECURITY**

1. Denmark
2. Slovenia
3. Finland
4. Canada
5. Latvia
6. Venezuela
7. Romania
8. United States
9. Sweden
10. Netherlands

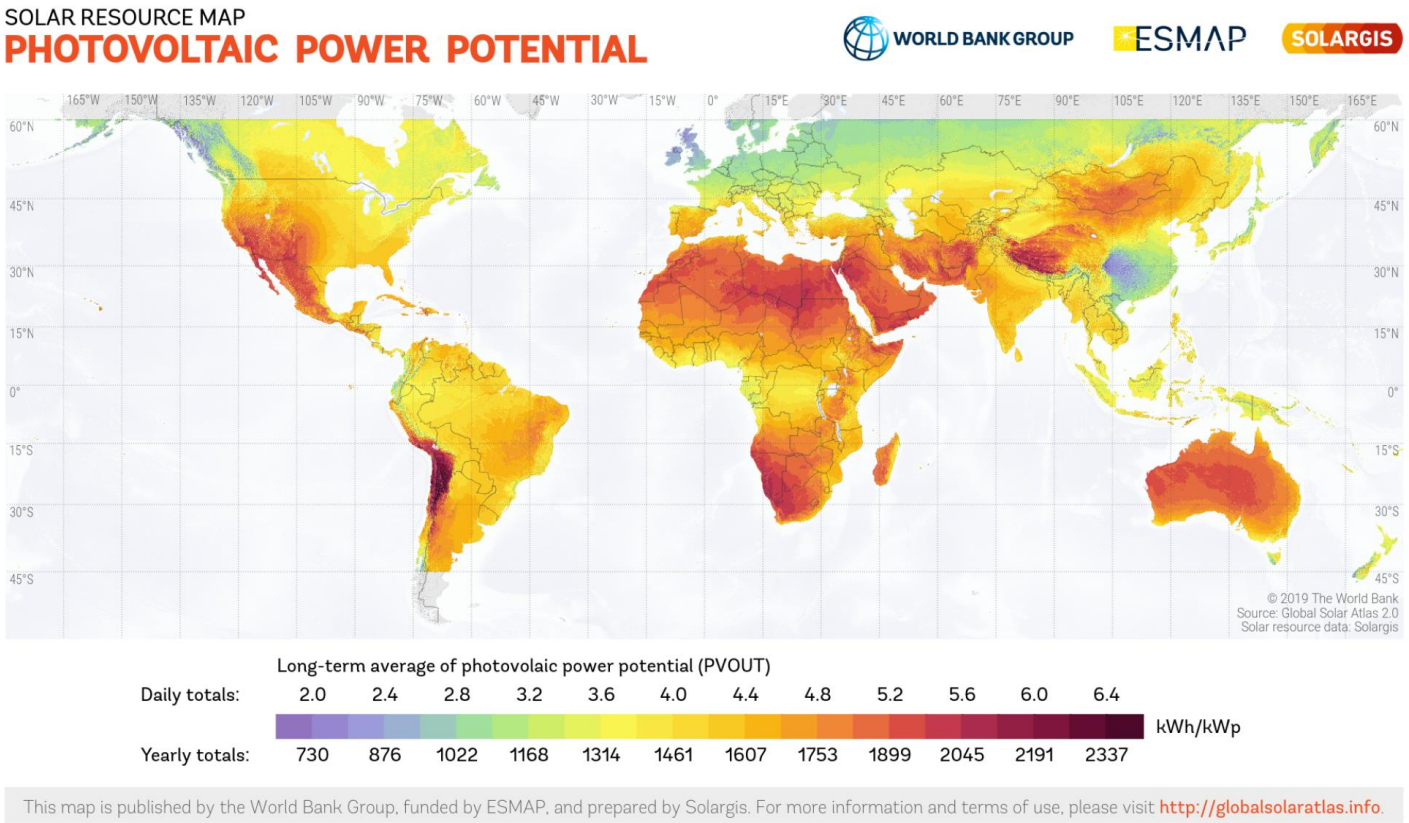
**TOP 10 ENVIRONMENTAL SUSTAINABILITY**

1. Philippines
2. Ireland
3. Switzerland
4. Denmark
5. Sweden
6. France
7. Costa Rica
8. Norway
9. United Kingdom
10. Uruguay

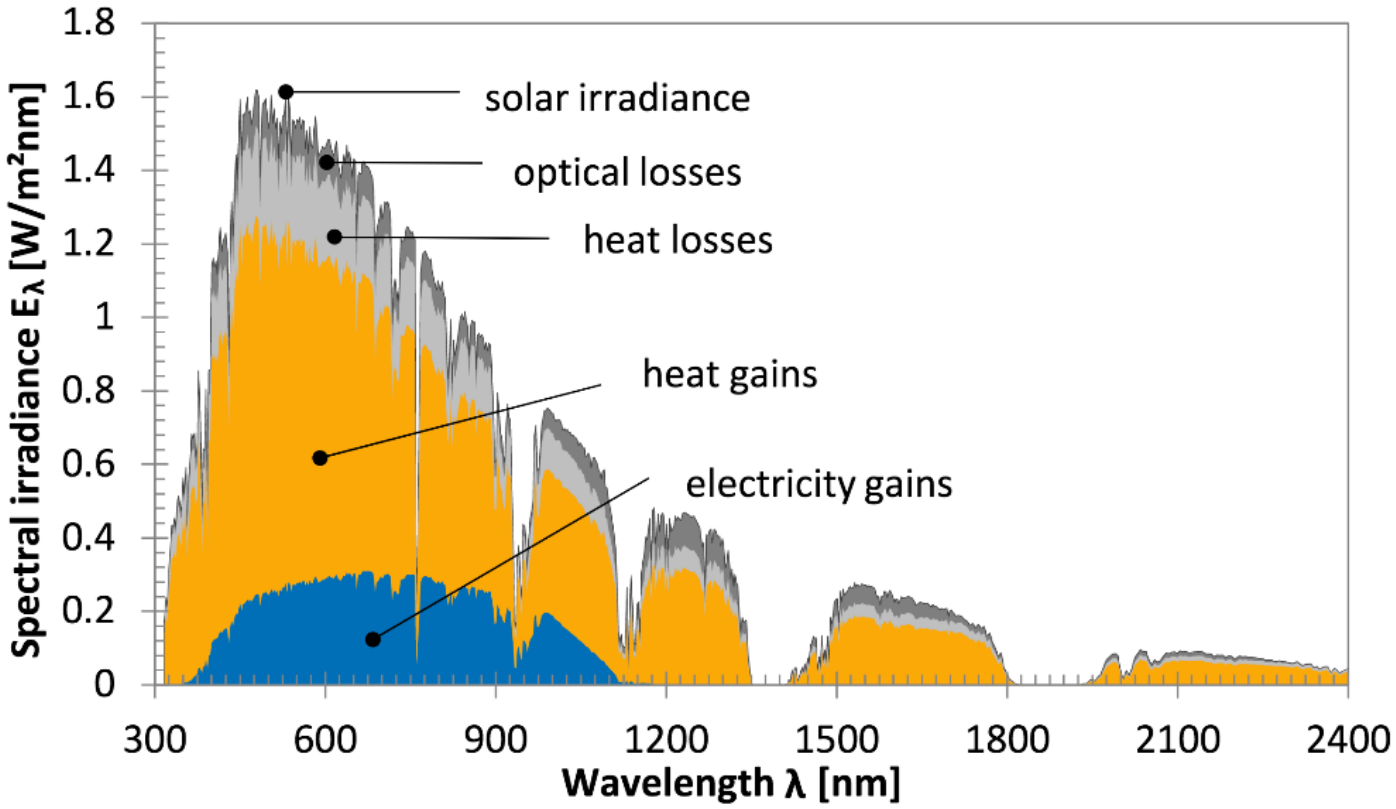
**TOP 10 ENERGY EQUITY**

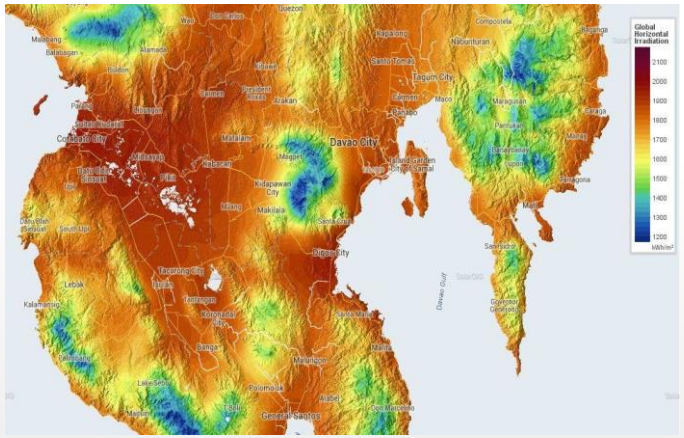
1. Luxembourg
2. Qatar
3. Netherlands
4. Switzerland
5. Bahrain
6. Kuwait
7. Czech Republic
8. Austria
9. Oman
10. Ireland

# Solar Resource

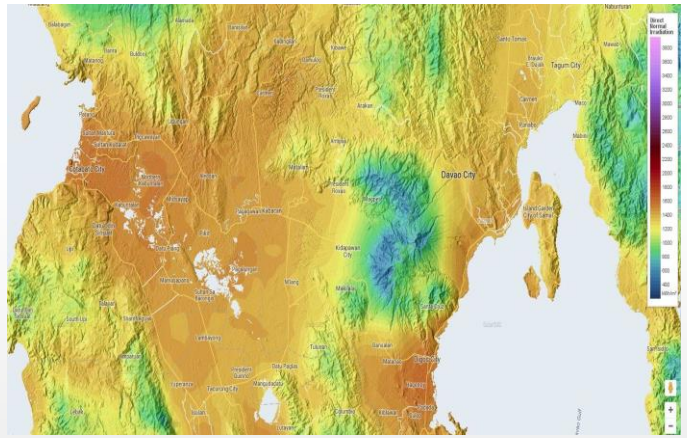


# Energy gains and losses from solar irradiance

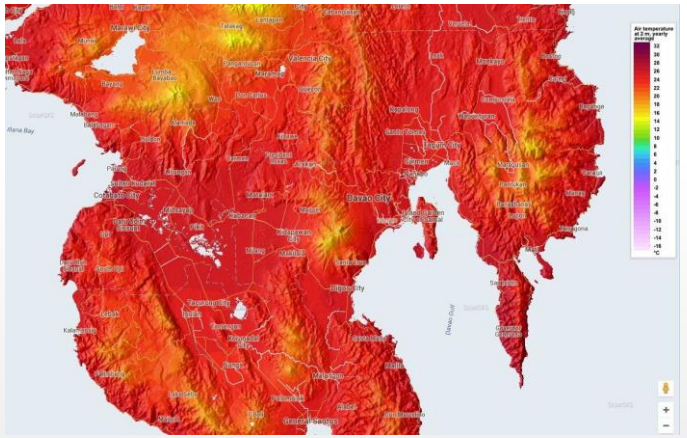





GHI

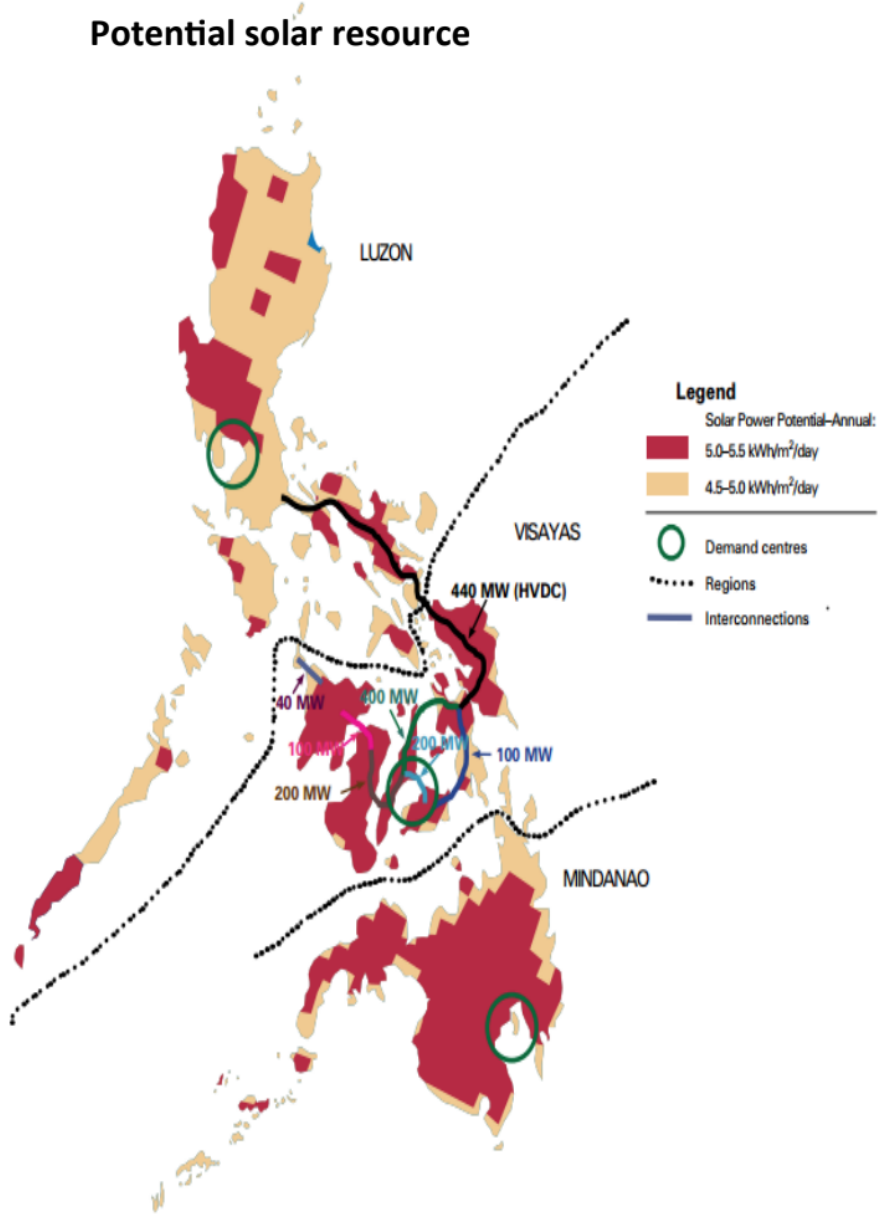



DNI

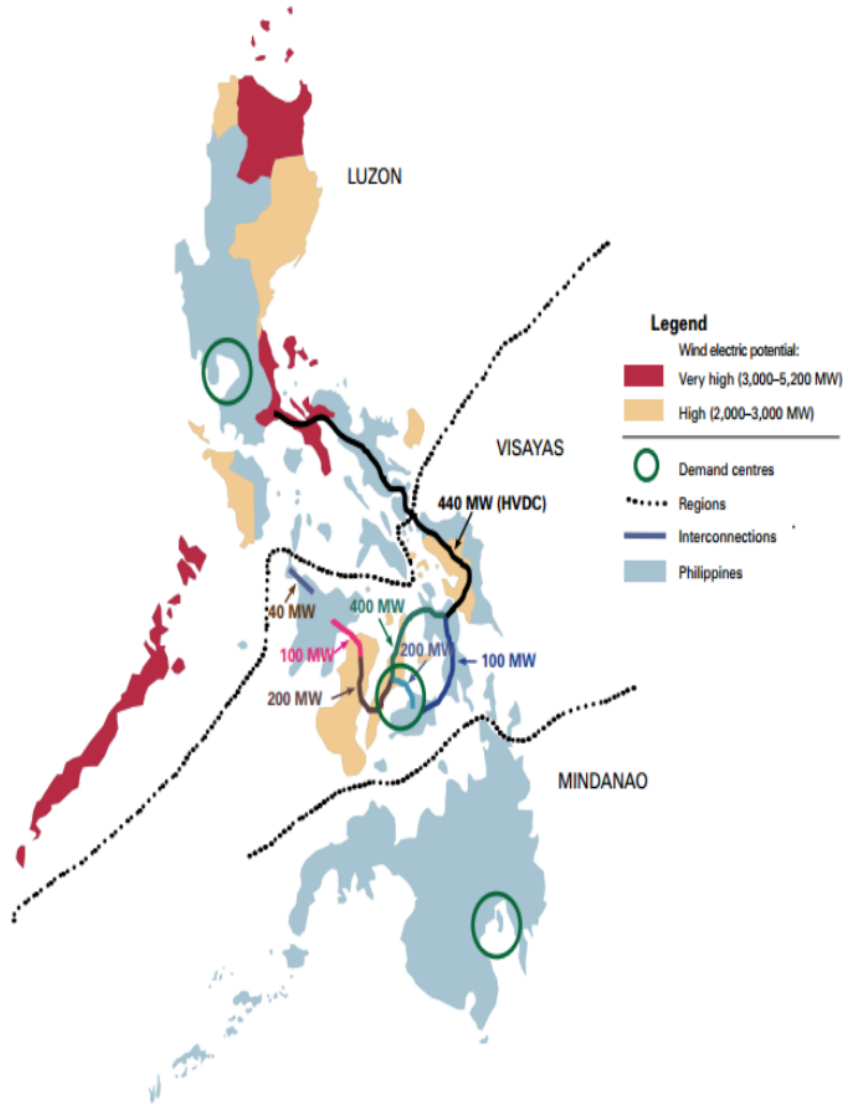



Ambient Temperature

## Potential solar resource

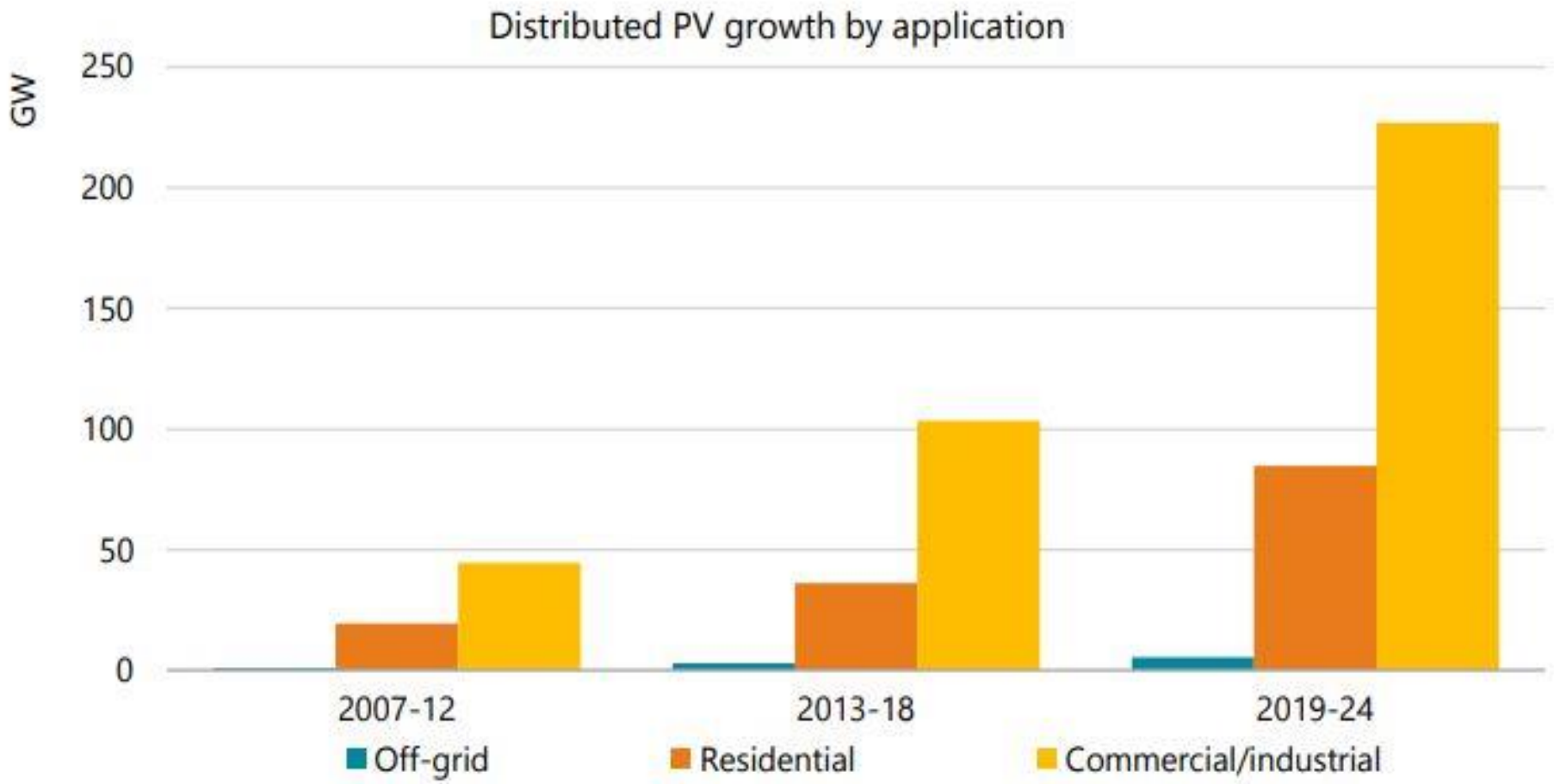



## Potential wind resource



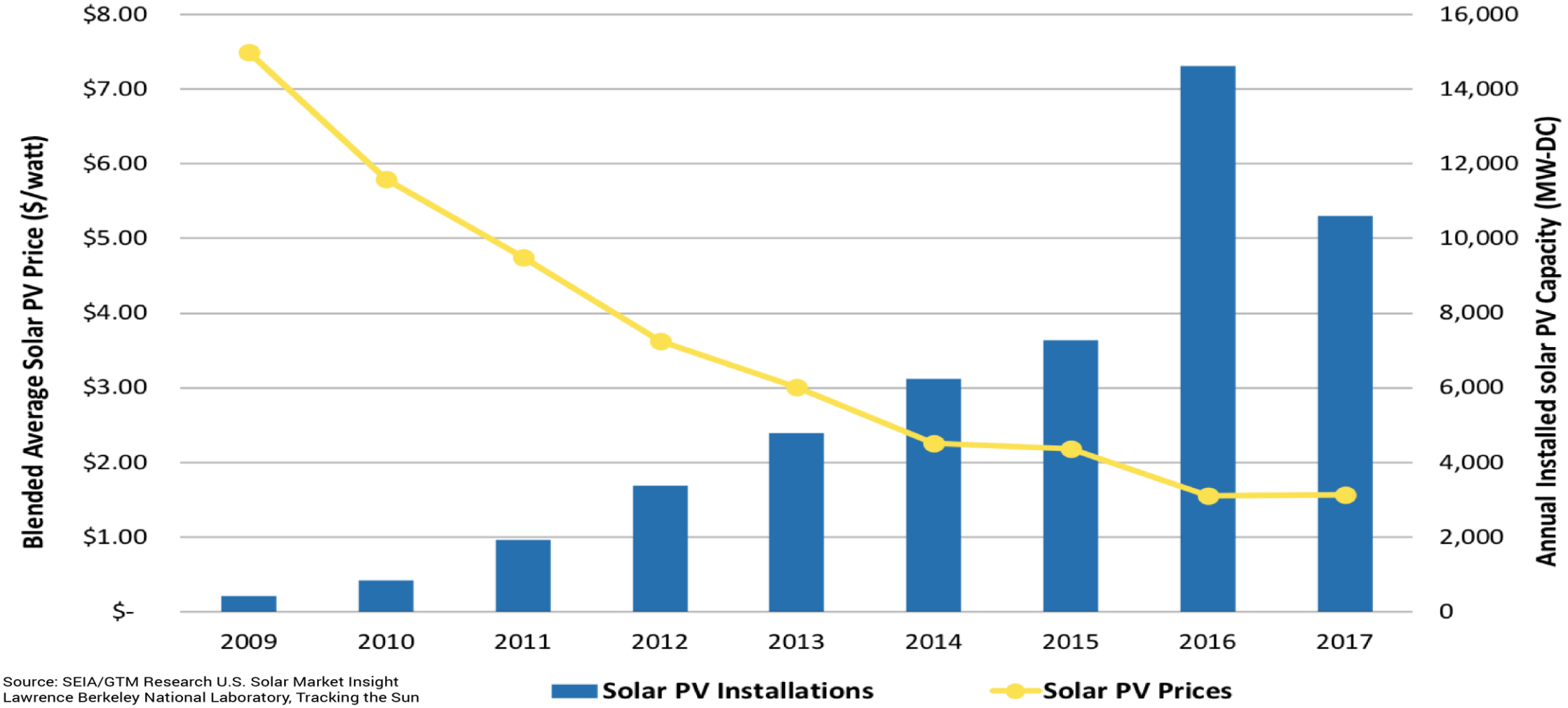

*Source: DOE/ERC/NREL/SolarGIS/NOAA/NCEP-CFSR*

# Commercial buildings and industry lead distributed PV growth



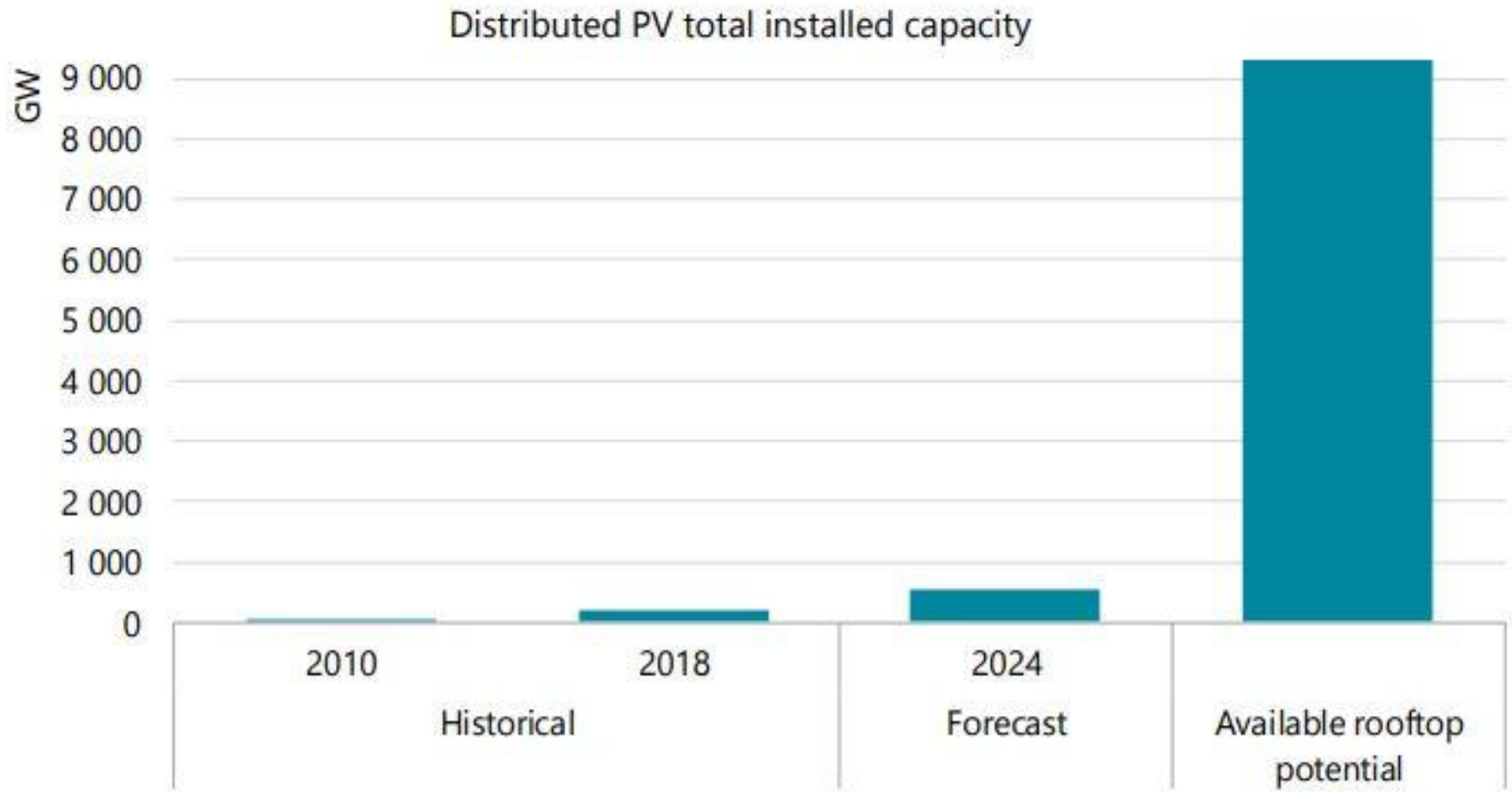

Economies of scale + better match between PV output and electricity demand in commercial/industrial applications enable higher self-consumption, saving more on electricity bills than in case of residential

# SOLAR PV INSTALLATION AND PRICES ARE DECREASING



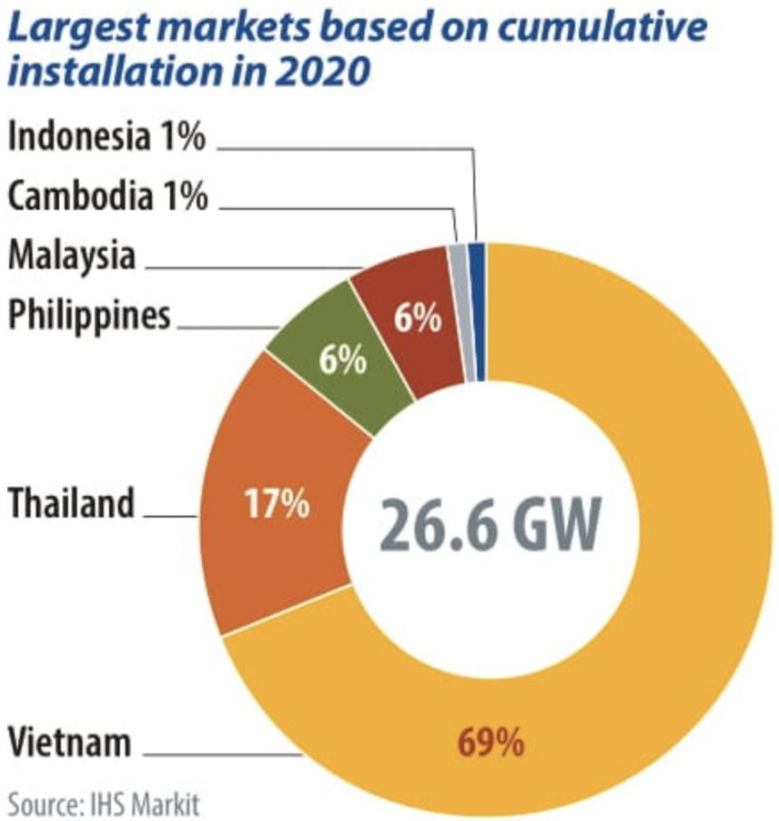

Source: SEIA/GTM Research U.S. Solar Market Insight
Lawrence Berkeley National Laboratory, Tracking the Sun

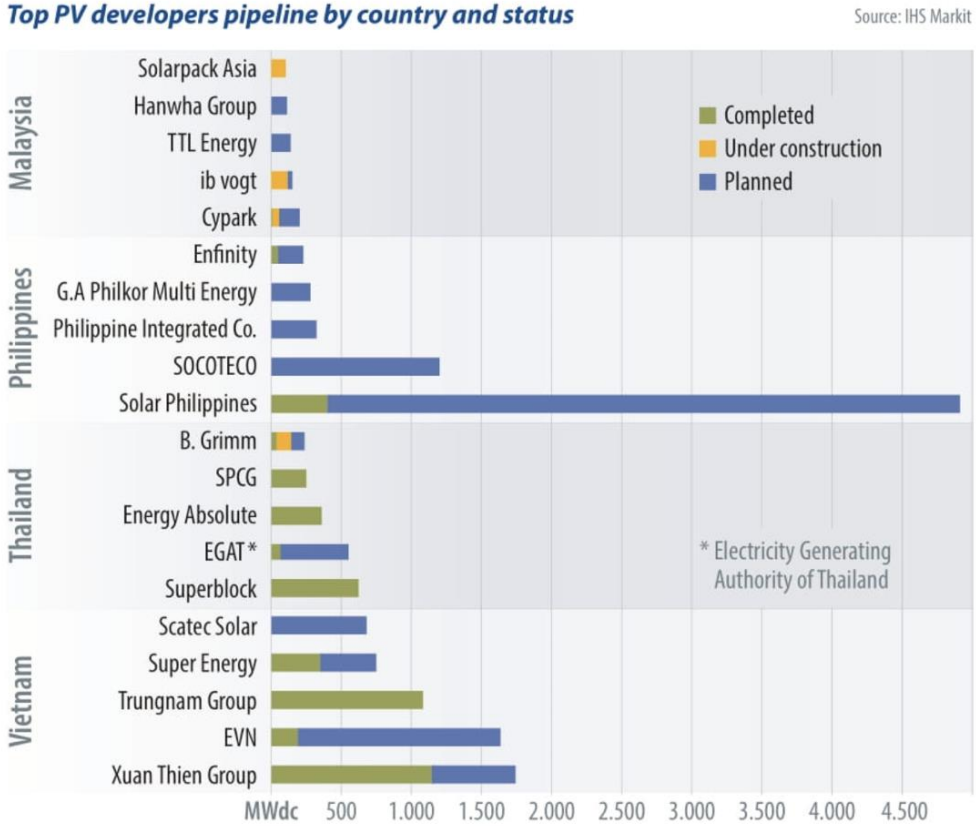
# Towards a distributed solar PV boom?




With improved policies, lower costs and rapid adoption, total distributed PV capacity more than doubles by 2024. However, this represents only 6% of the global technical potential.

# ASEAN Solar PV markets



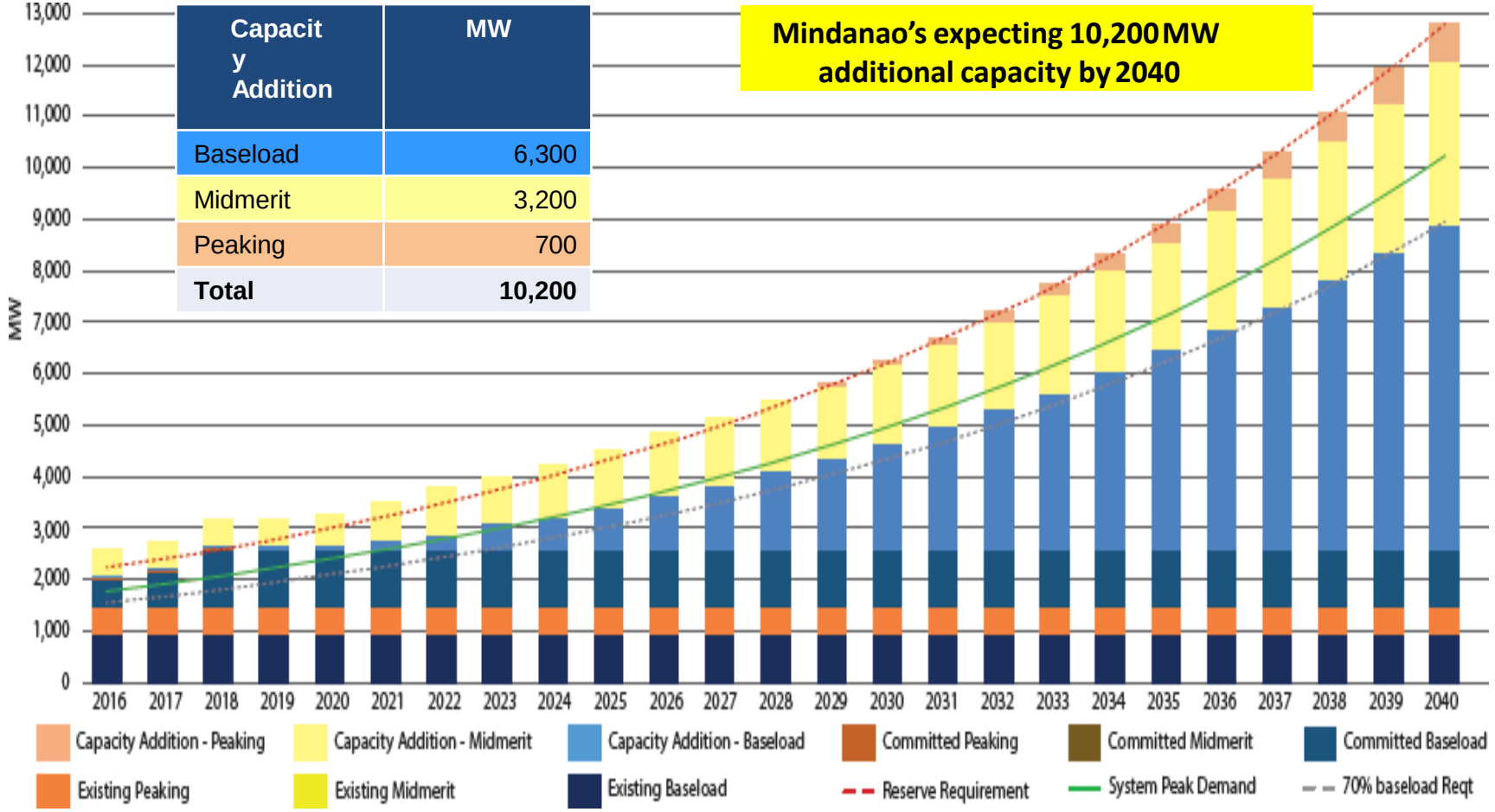



# Power Development Plan, 2016-2040

## Mindanao Demand and Supply Outlook, 2016-2040

| Capacity Addition | MW |
|---|---|
| Baseload | 6,300 |
| Midmerit | 3,200 |
| Peaking | 700 |
| **Total** | **10,200** |

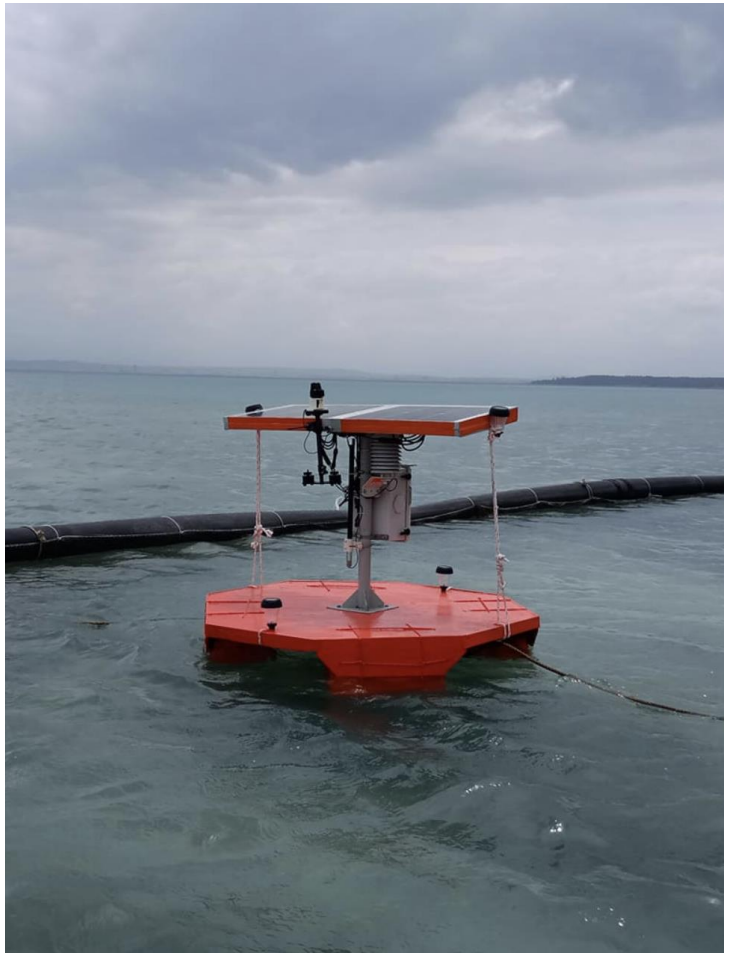
**Mindanao's expecting 10,200 MW additional capacity by 2040**






Source: 2016-2040 DOEPower Development Plan

# Meso-Scale Meteorological Monitoring Infrastructure

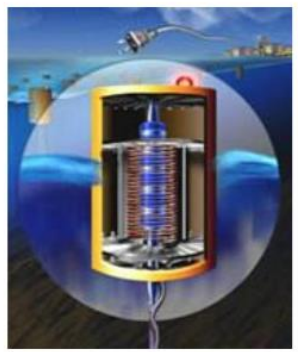


# ORE

- A type of renewable energy technology that harnesses the motion of sea water.

Wave

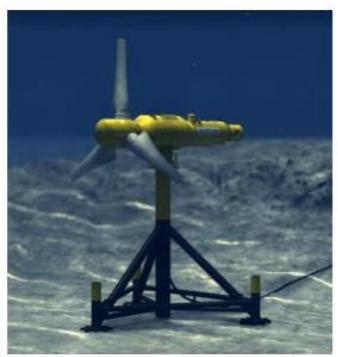

Wave Hydrokinetic Pump



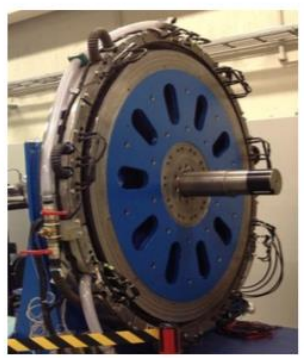
Wave Linear Generator

Submarine Power Cable

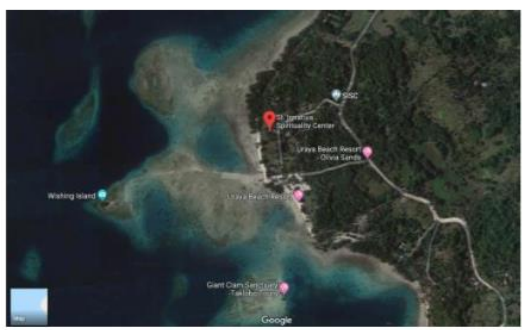
Tide



Tidal Turbine



Axial Generator



St. Ignatius Spirituality Center

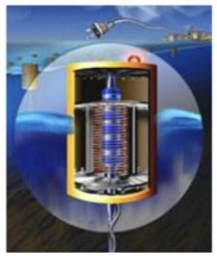
MREC

# Ocean Renewable Energy

- A type of renewable energy technology that harnesses the motion of sea water.

Wave

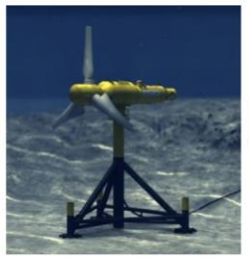

Wave Hydrokinetic Pump



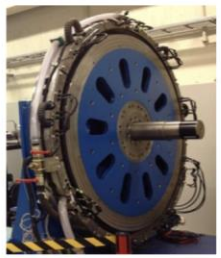
Wave Linear Generator

Submarine Power Cable

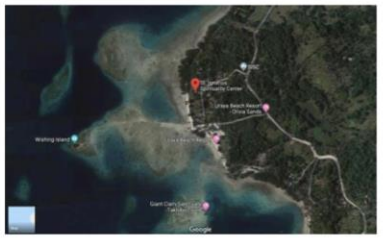
Tide



Tidal Turbine



Axial Generator



St. Ignatius Spirituality Center

# Design and Performance Evaluation of an Ocean Renewable Energy System

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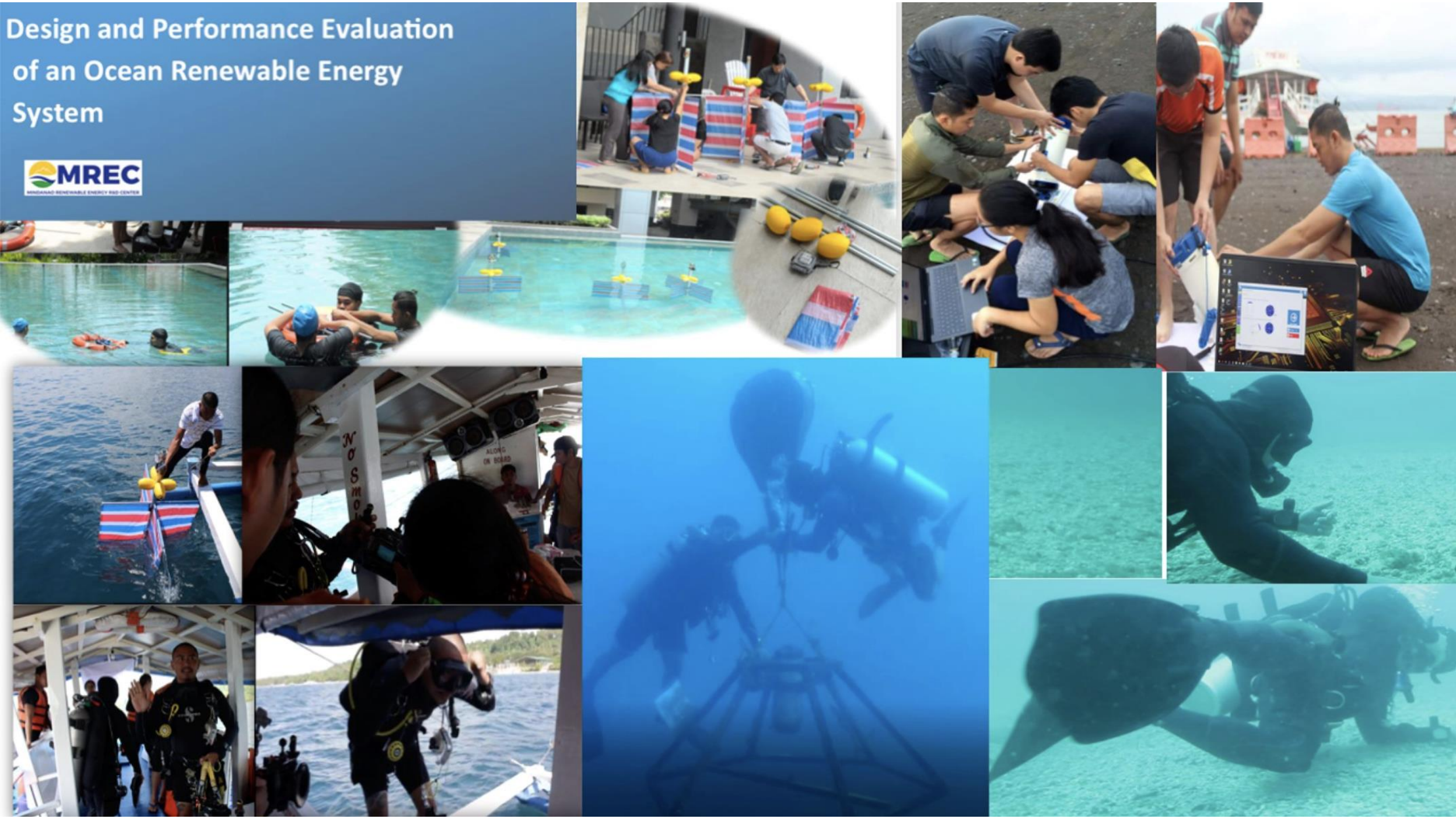



District
Sta. Ana Wharf
DAY 1

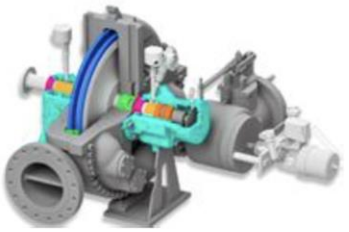
# Concentrated solar power

- A type of solar technology that utilizes optical materials to direct sunlight and converts heat into clean and renewable energy.

Sunlight

Reflector

Thermal Storage



Steam Turbine

Power Generator


Location (AdDU, Matina Campus)

# Steam Power Plant Installation

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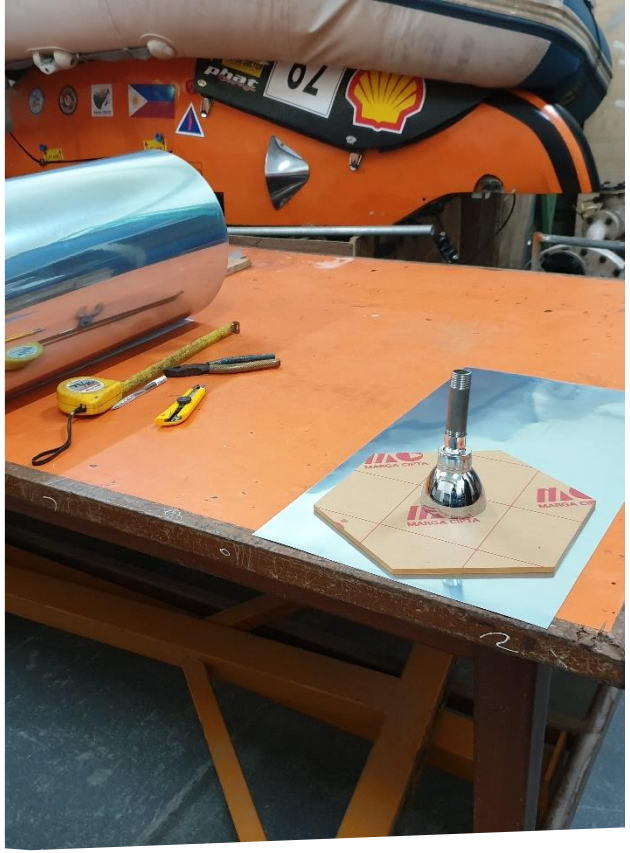

# Fabrication of hexagonal reflectors

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# Construction of Parabolic Dish Structure

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# Philippine policies supporting sustainable energy systems

- EPIRA Law of 2001 (RA 9136)
- Biofuels Act of 2006 (RA 9367)
- Renewable Energy Act of 2008 (RA 9513)
- Energy Efficiency and Conservation Act of 2019 (RA 11285)

# Renewable energy support policies in selected countries

Solar PV is a mature technology; innovations in policies, rules and regulations, and financing schemes are lagging behind.

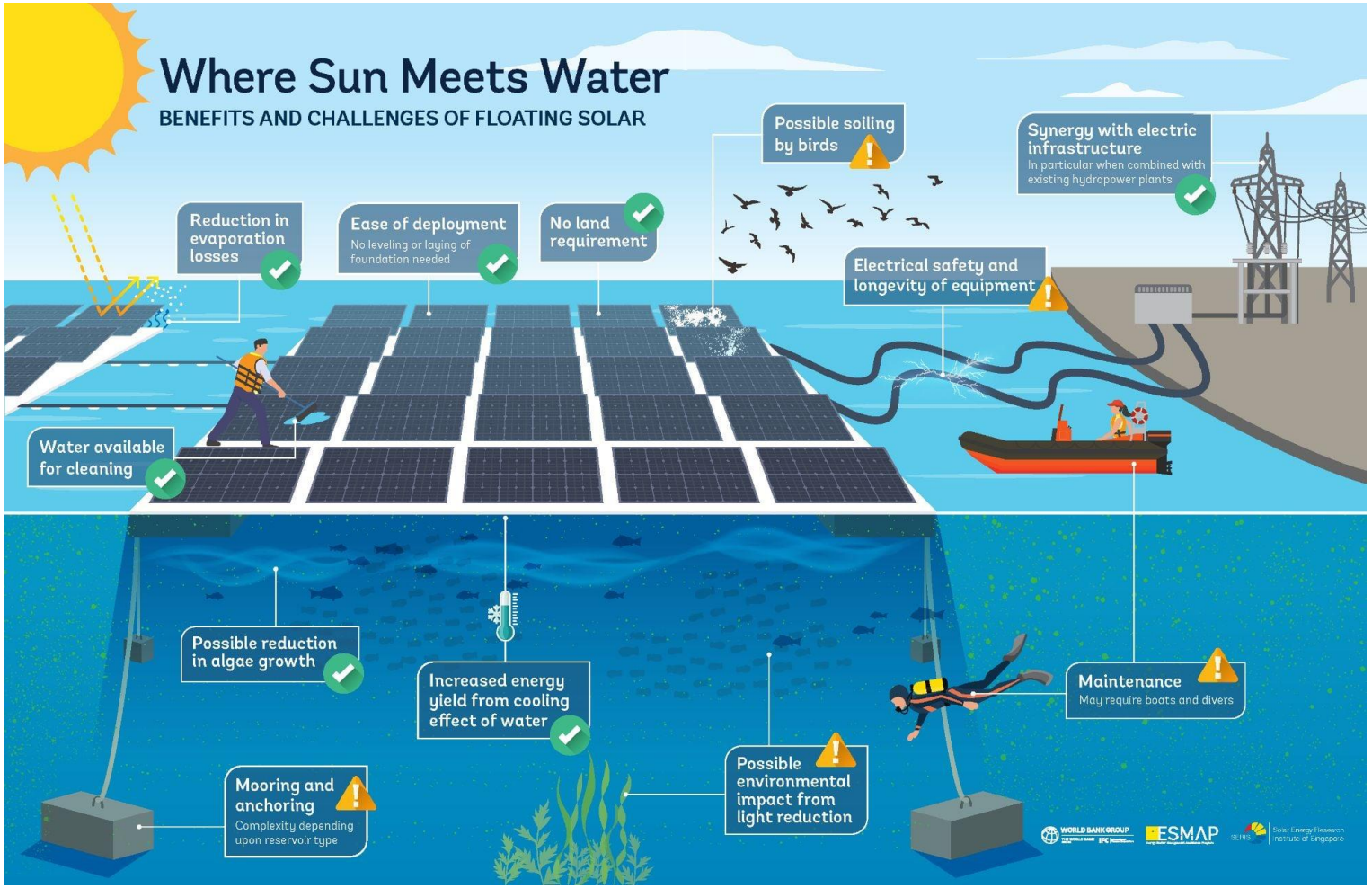
| | Regulatory Policies | | | | | Fiscal Incentives and Public Financing | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Feed-in Tariff | Renewable Portfolio Standard/Quota | Net metering | Tradable Renewable Energy Certificates | Tendering/Auction/Public competitive bidding | Capital subsidies, Grants, Rebates | Investment or production tax credits | Reductions in taxes (e.g. sales, energy, CO2, VAT or other taxes) | Energy production payment | Public investment, loans, or grants |
| Brazil | | | ✓ | | ✓ | | ✓ | ✓ | | ✓ |
| Chile | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| United States | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| United Kingdom | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ |
| Germany | ✓ | | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Italy | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| China | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Japan | ✓ | | | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| South Korea | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ |
| India | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Indonesia | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Malaysia | ✓ | ✓ | | | | | | ✓ | | ✓ |
| Philippines | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Singapore | | | ✓ | | ✓ | | | | | ✓ |
| Thailand | ✓ | | | | | ✓ | | ✓ | ✓ | ✓ |
| Viet Nam | ✓ | | | ✓ | | ✓ | ✓ | ✓ | | |

Source: Adapted from (GIZ, 2012) and (REN21, 2016).

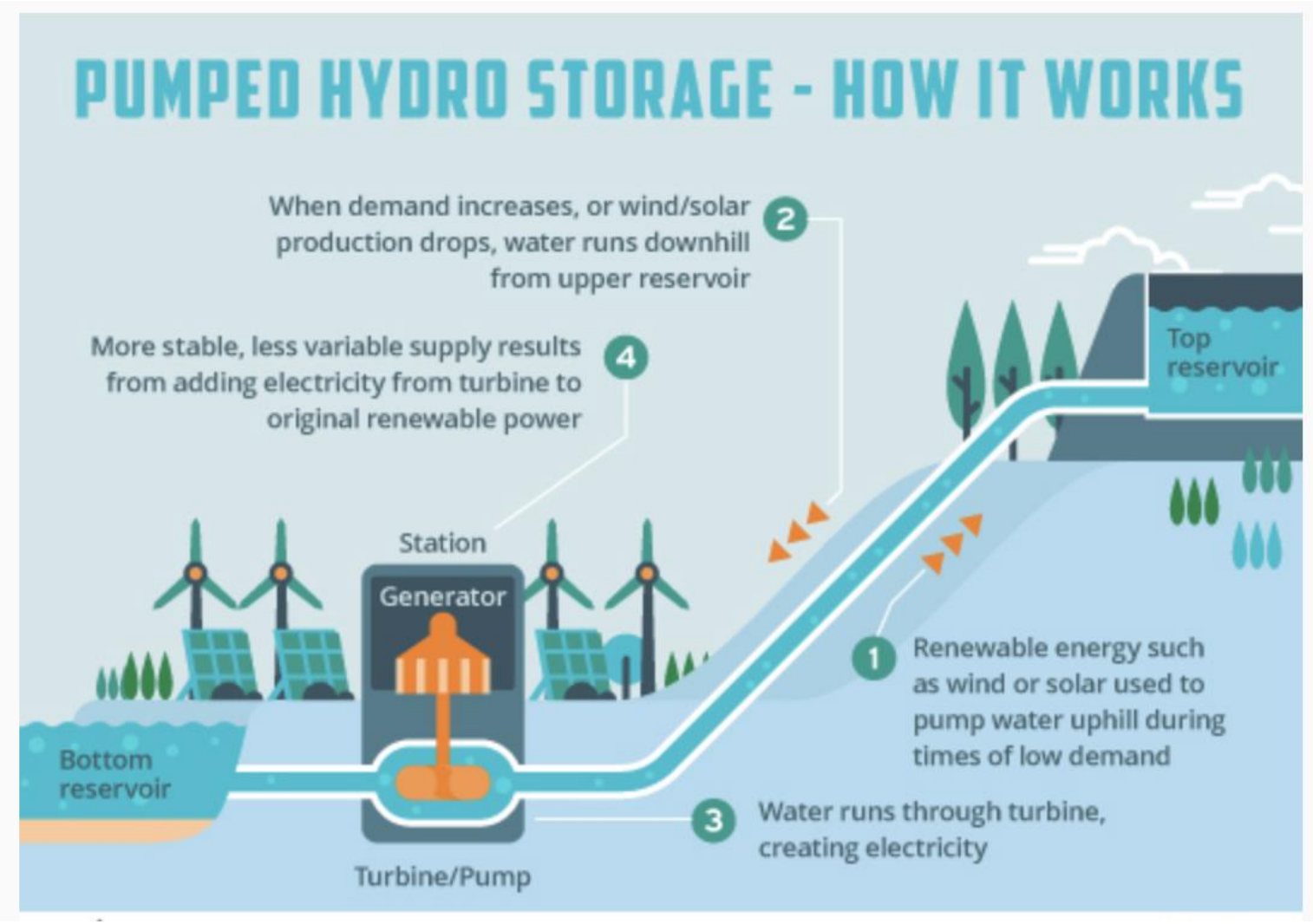
# Rooftop renting for Solar PV System (Schlierberg, Germany)

# Solar charging stations for electric vehicle

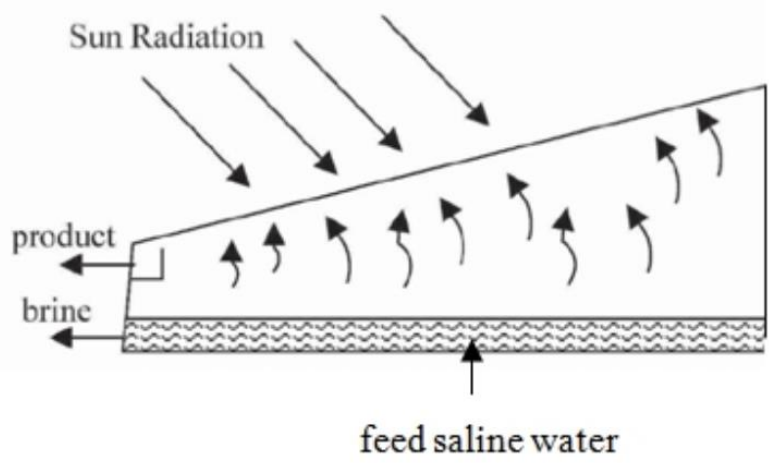
# Floating Solar



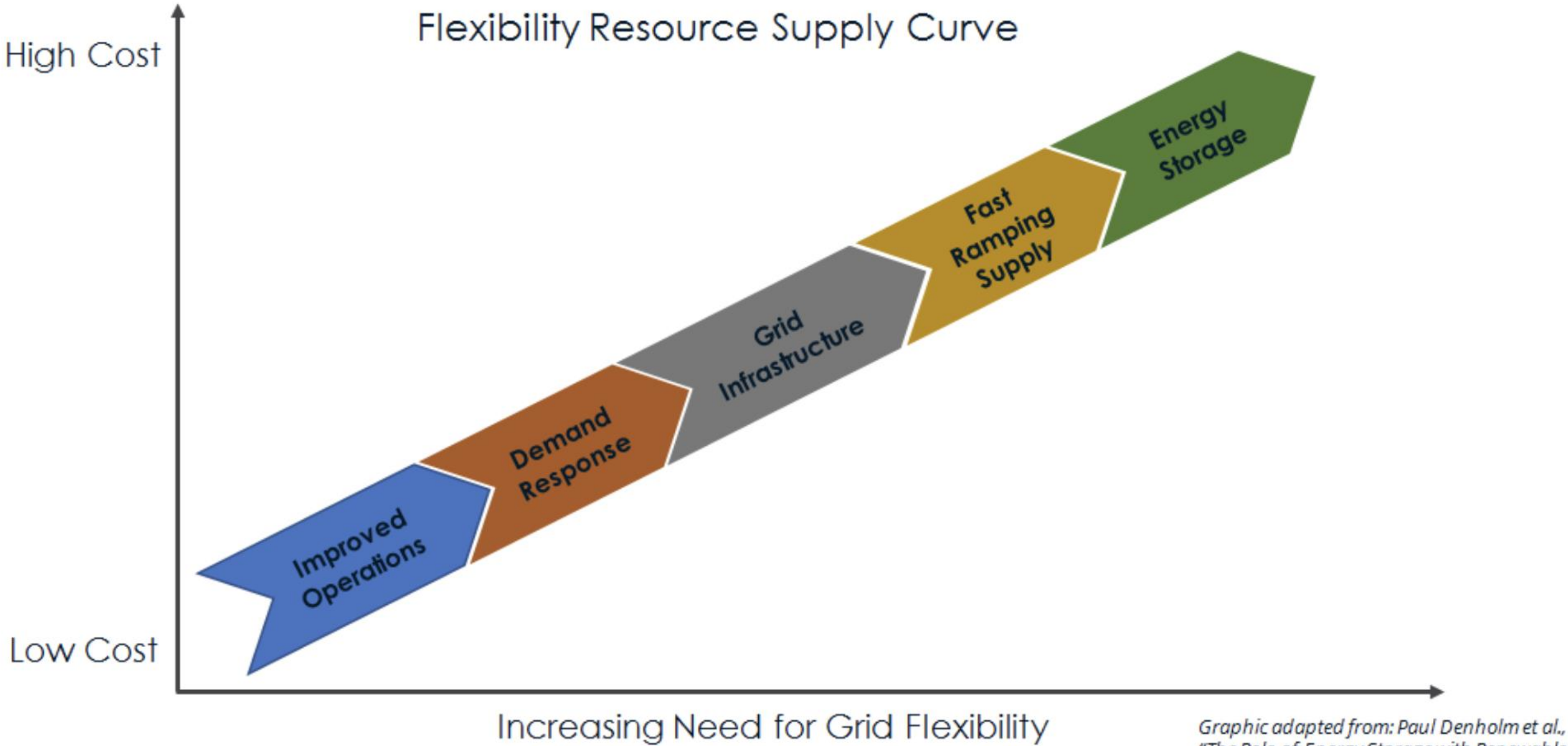
# Pumped Hydro Storage



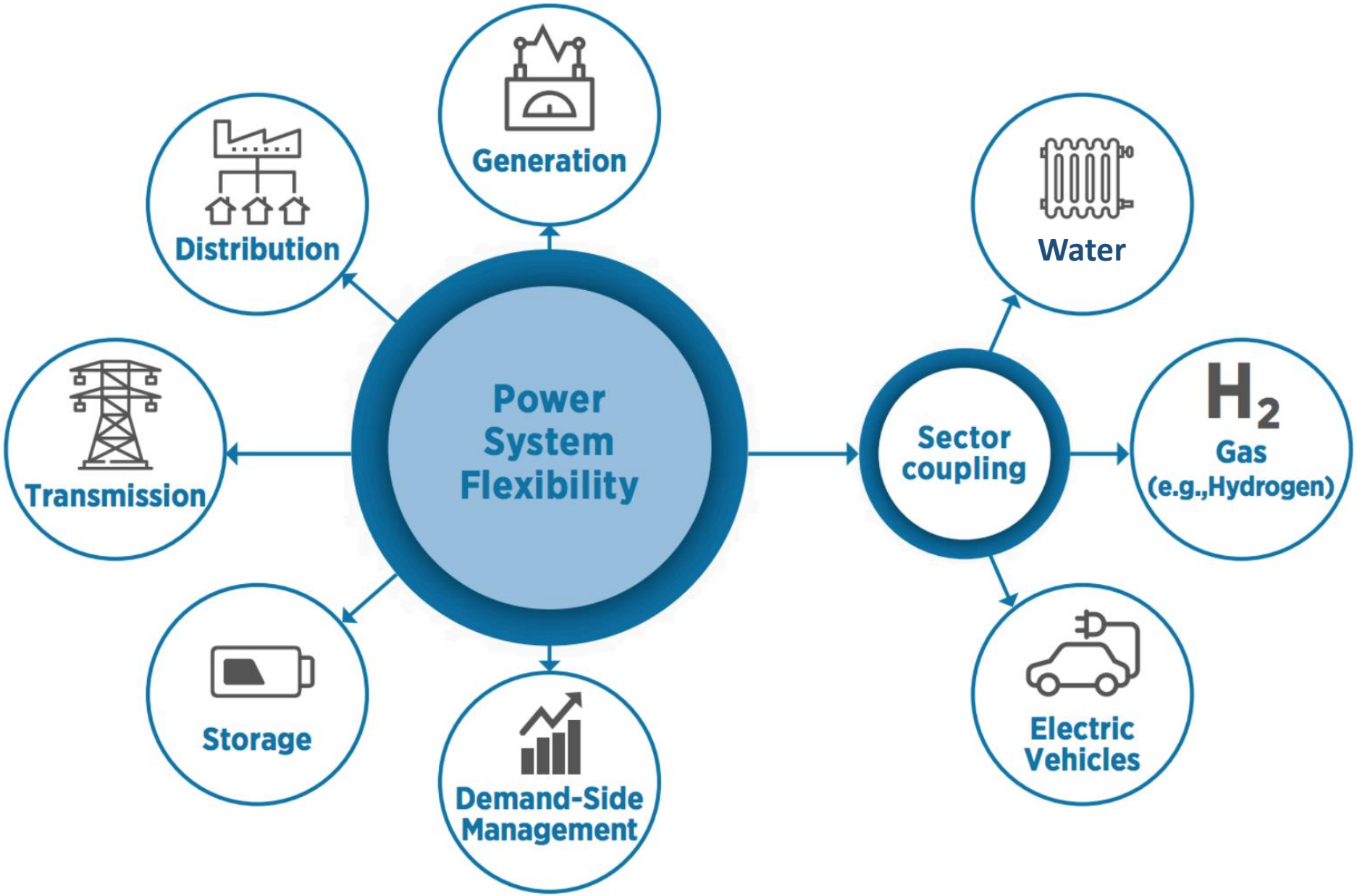
# Solar desalination



# Solar water pump




*Graphic adapted from: Paul Denholm et al., "The Role of Energy Storage with Renewable Electricity Generation," NREL, 2010.*


Generation
Distribution
Transmission
Power System Flexibility
Storage
Demand-Side Management
Sector coupling
Water
$H_2$
Gas (e.g.,Hydrogen)
Electric Vehicles

# Key advocacy areas for renewable energy

- Greater deployment of rooftop solar through:
  - Standard incorporation of solar PV in the rooftops of government establishments to reduce electricity cost and adapt better in the aftermath of extreme weather disaster
  - Standard incorporation of solar PV in the building industry
  - Parity pricing between the grid-electricity and solar electricity for net metering
  - Develop mechanisms for rooftop renting for solar PV
- Improvement of the renewable energy access of GIDA areas in Mindanao (RE in missionary electrification)
- Greater integration of energy efficiency and conservation in establishments
- Greater integration of renewable energy in the transportation sector

# Opportunities for renewable energy technology investments in Davao Region

- Generation-> large scale RE  (solar and wind farms); distributed RE (solar rooftops); RE for SPUG areas (solar, tidal, CSP); flexible generators (ancillary service)
- Networks (Transmission and Distribution) -> build transmission networks in high RE areas; solar charging stations
- Storage -> pumped hydro-storage; battery storage
- Demand side management -> time of use tariffs; generators for interruptible load
- Sector coupling with electricity-> Transportation (electric vehicle); gas; water (RE desalination, solar water pump)

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