From Dreams to Reality: Achieving NDCs through Power Sector Planning and Implementation

Asia Clean Energy Forum - Deep Dive Workshop

June 18, 2021

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Stakeholder Engagement and Ensuring a Just Energy Transition

Paty Romero-Lankao, NREL

A series of trends and challenges can be harnessed to support a clean and just energy transition

E-mobility

Expected expansion of electric vehicles (EVs). Since 2010, EVs & chargers grew to 7.2 and 7.3 million and battery costs decreased 85%

COVID-19

Rebuild & create synergies between carbon free mobility-grids, jobs, & economic productivity

Buildings

Shift to grid-interactive, electrified connected, & resilient communities through deployment of distributed energy resources (DERs)

Policies

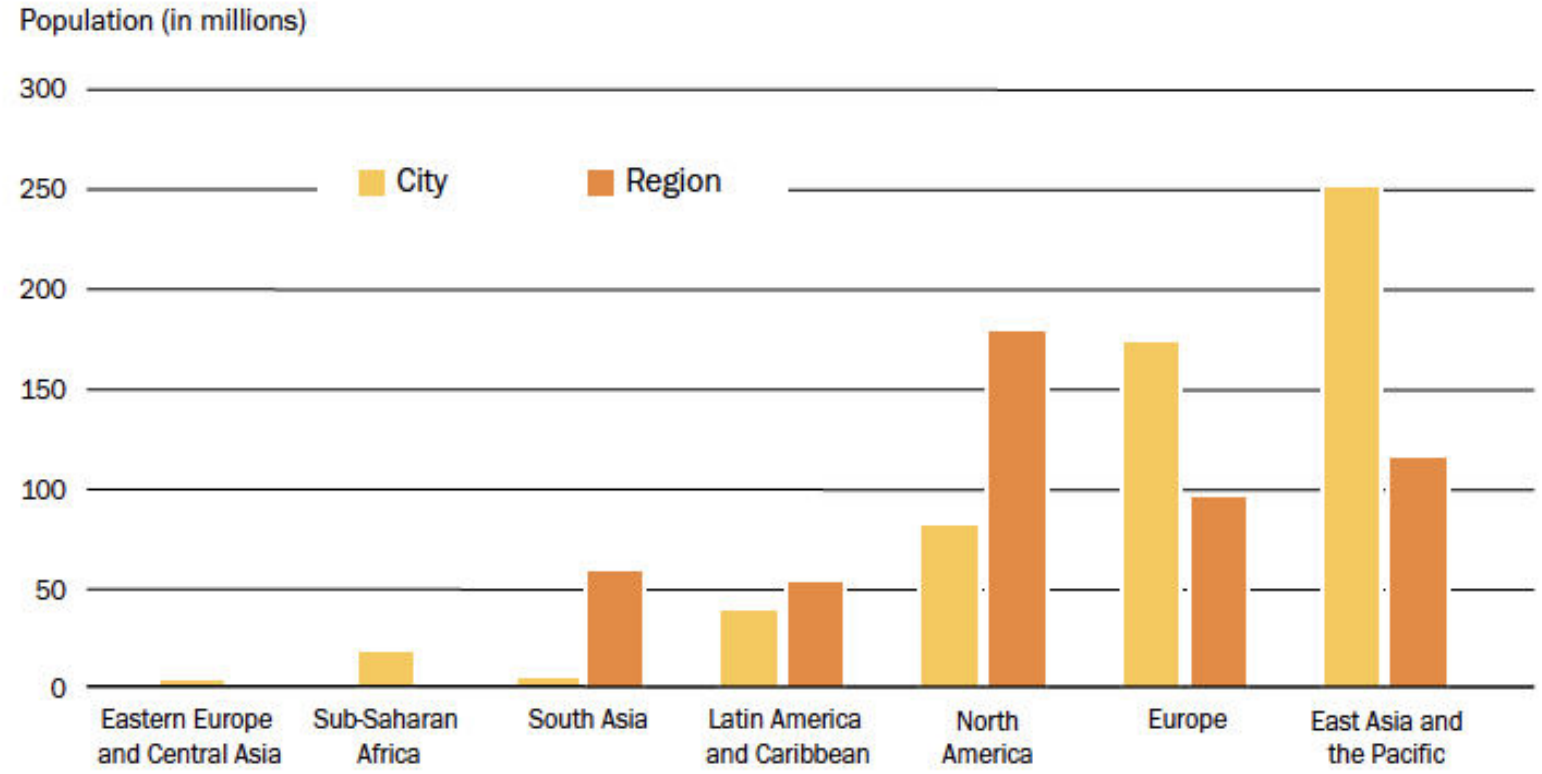
Major influence - from subsidies and regulations (e.g., ZEVs) to land-use planning

Power Sector

Shift to distributed systems powered by renewables & driven by end-use electrification

Policies have major influences

State and local governments, representing **21%** of the global economy and **672 million** people, have pledged emissions reduction compared to a base year



Data source: various

Hsu, A., et al (2020).

Examples of EV Policies in Selected Regions

		Canada	China	European Union	India	Japan	United States
Regulations (vehicles)	ZEV mandate	✓*	✓				✓*
	Fuel economy standards	✓	✓	✓	✓	✓	✓
Incentives (vehicles)	Fiscal incentives	✓	✓	✓	✓		✓
Targets (vehicles)		✓	✓	✓	✓	✓	✓*
Industrial policies	Subsidy	✓	✓			✓	
Regulations (chargers)	Hardware standards**	✓	✓	✓	✓	✓	✓
	Building regulations	✓*	✓*	✓	✓		✓*

Source: IEA 2020

However, policies and innovations can:

- be seen as incompatible with community realities

- disproportionately affect some groups while benefitting others

- serve to exacerbate inequality and injustice

Romero-Lankao et al. 2021

What have we learned so far about energy transitions?

What lessons and best practices can be adapted to NDC projects?

Equality

The assumption is that **everyone benefits from the same supports**. This is equal treatment.

Equity

Everyone gets the supports they need (this is the concept of "affirmative action"), thus producing equity.

Justice

All 3 can see the game without supports or accommodations because **the cause(s) of the inequity was addressed**. The systemic barrier has been removed.

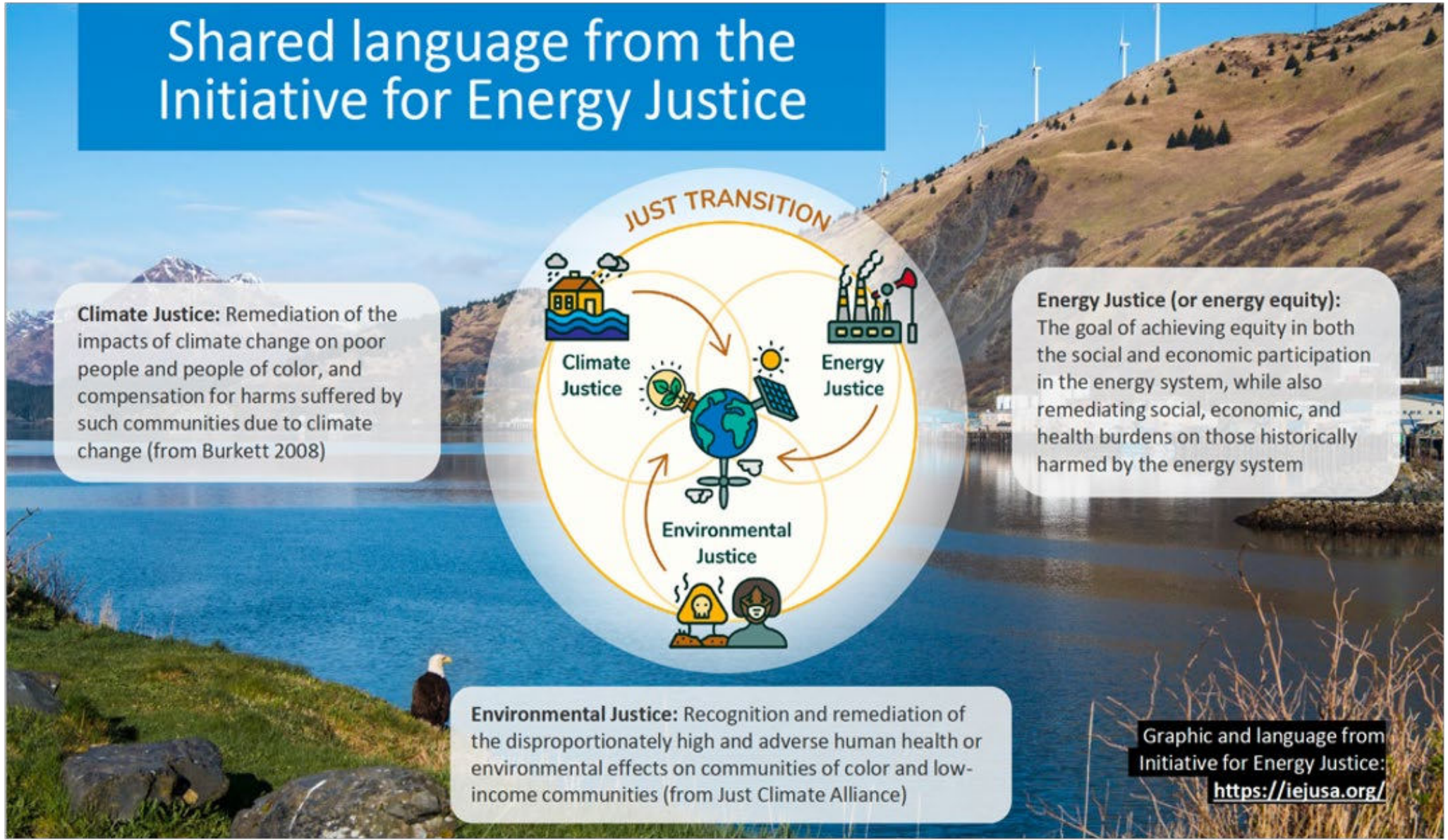
Core Tenets of Energy Justice

Procedural Justice to more meaningfully enable participation of underserved communities

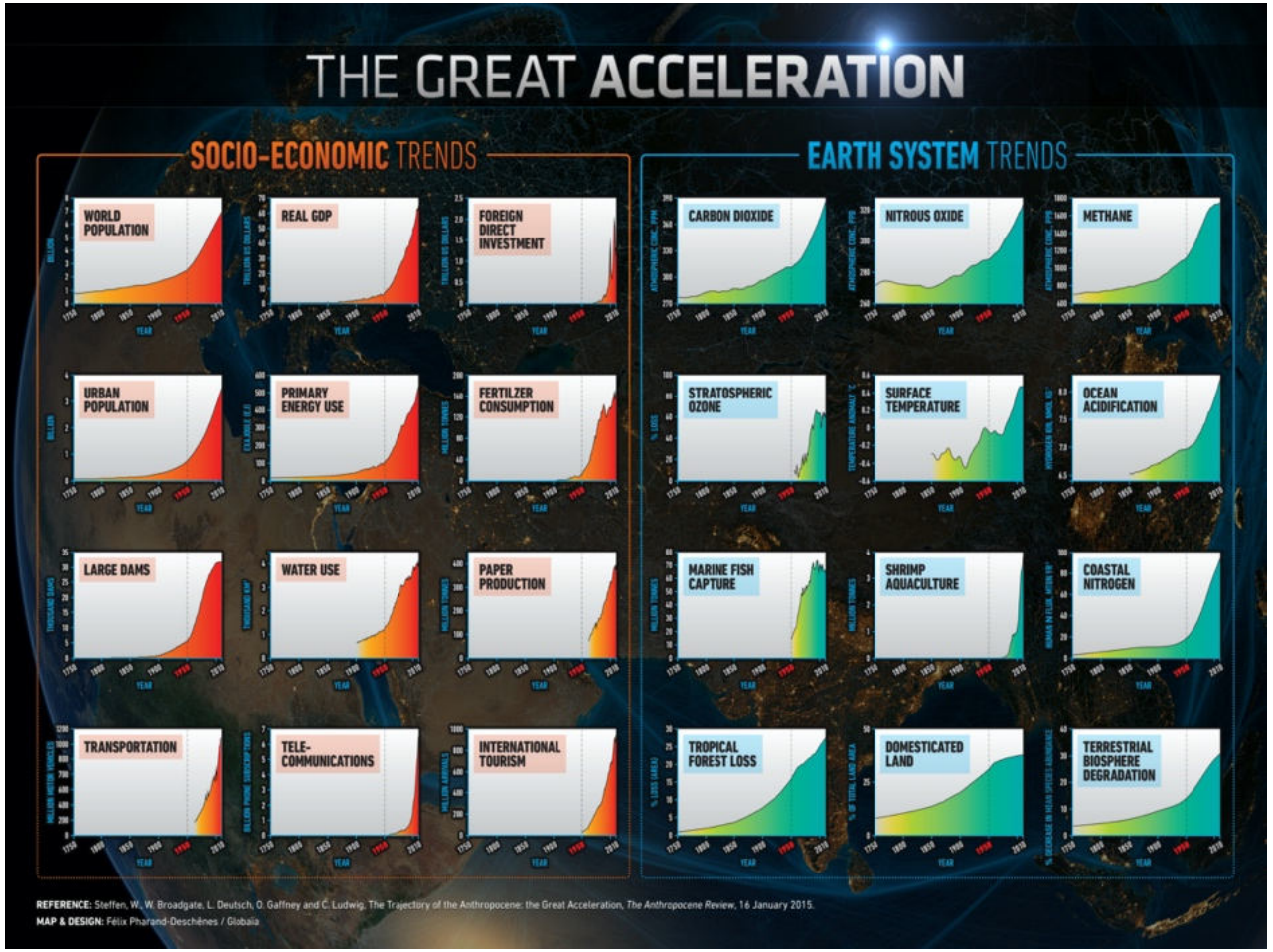
Recognition Justice to listen to and address past energy inequities

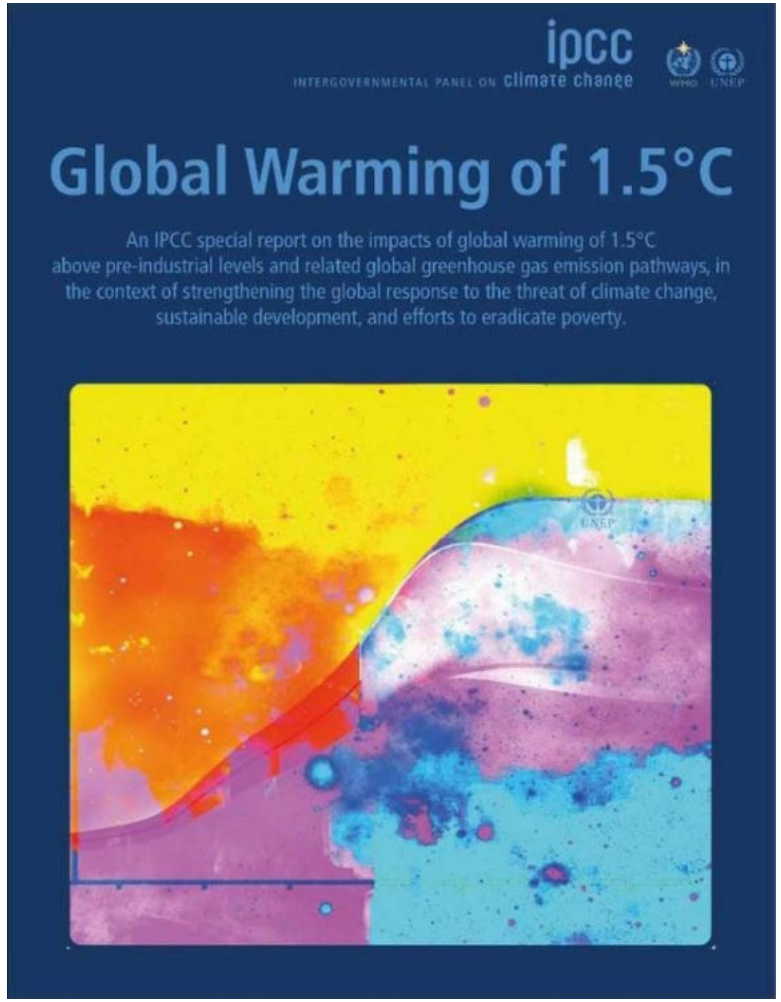
Distributional justice to implement clean energy transitions while improving energy justice outcomes

Climate, Environmental, and Energy Justice



The Scale and Mismatch Between Imperative for a Deep and Fast Transition





Steffen et al, 2015

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Energy transitions have been, and will continue to be, inherently prolonged affairs

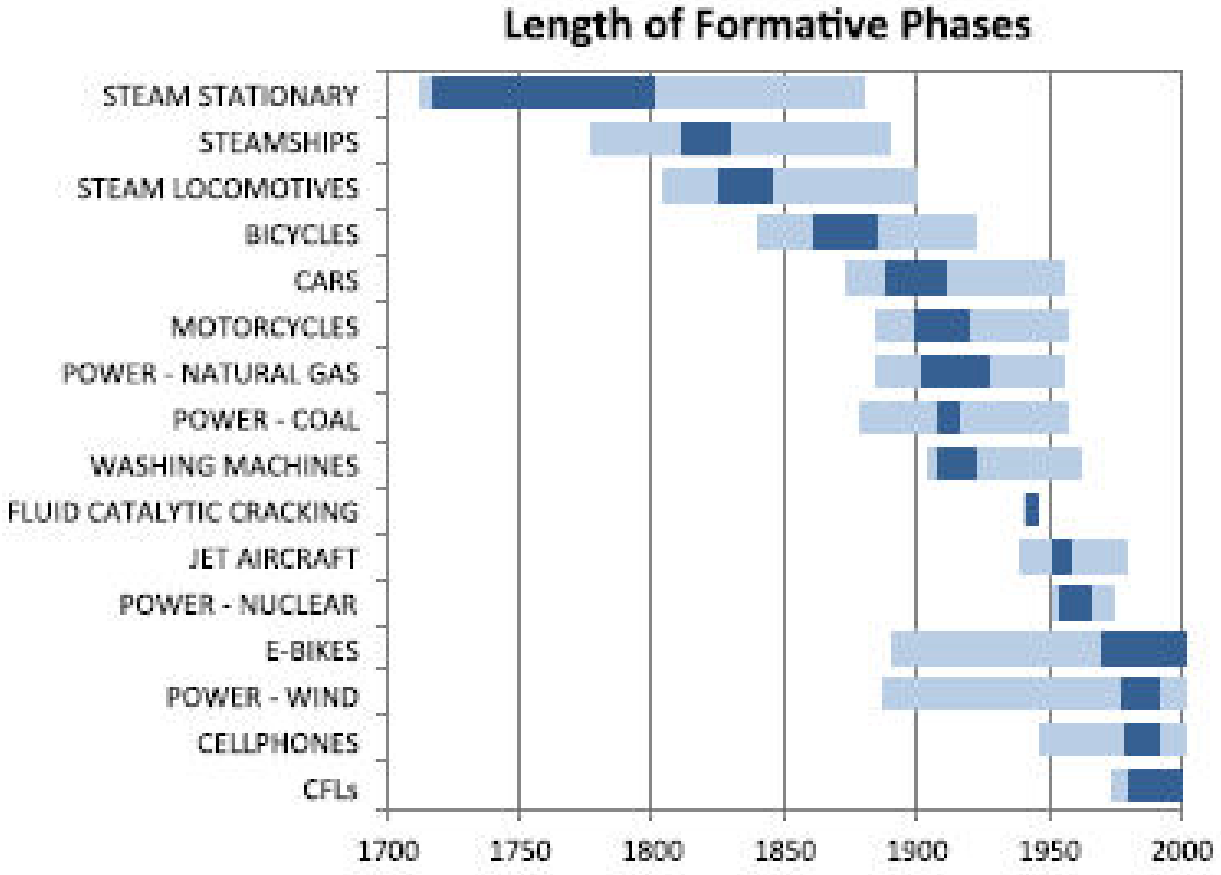


Fig. 1. Durations of formative phases for energy technologies are at a decadal scale [4]. Note: Ranges refer to alternative definitions for the start and end points of formative phases, and so capture measurement uncertainties.

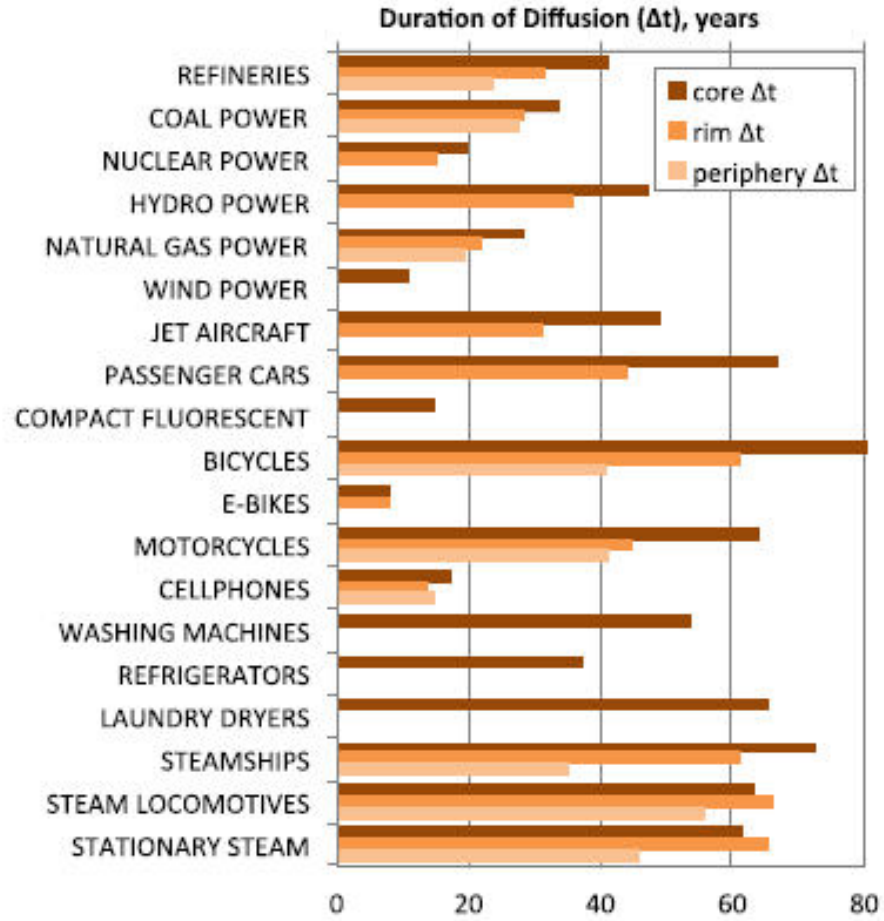
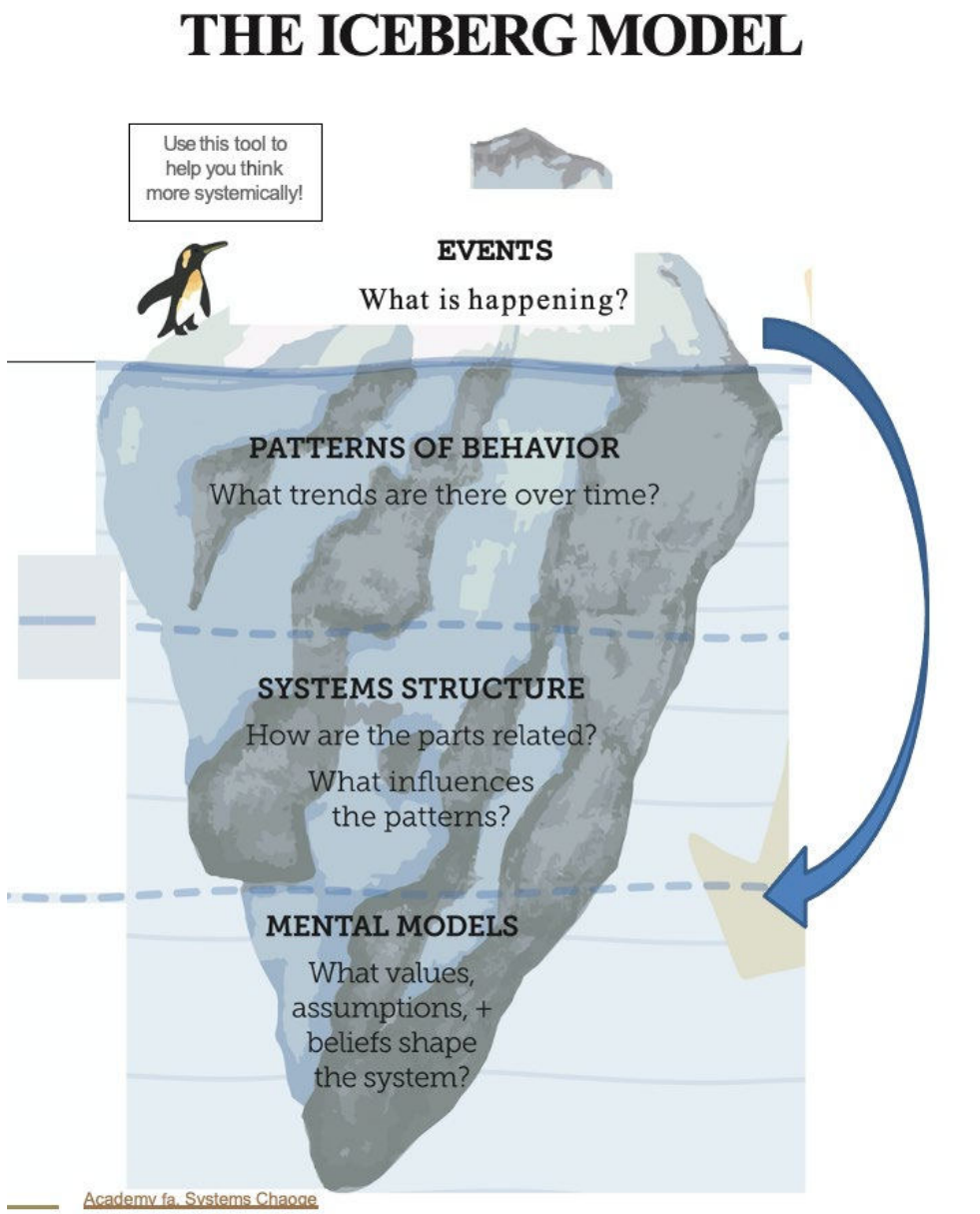


Fig. 2. Diffusion speeds accelerate as technologies diffuse spatially. Notes: Bars show durations of diffusion measured by cumulative total capacity installed, with historical data fitted via a logistic growth curve and the diffusion duration expressed as Δ t in years. 'Core' is typically within the OECD; 'Rim' is typically Asian countries; 'Periphery' is typically other world regions. For details and data, see: [42,3].

Sovacool 2021

Systems thinking is needed.

- We often focus on the “shallow” points and levers of change
  - Individual behavior
  - Flows of resources
- Sometimes we target structural, systemic factors
- We need to target deeper leverage points
  - World views, values and identities shaping energy system configurations



Source: donellameadows.org

Energy transitions can perpetuate or aggravate historic inequities, including:

1. Who has/will benefit and who has/will experience negative impacts
   - *Distributive justice*

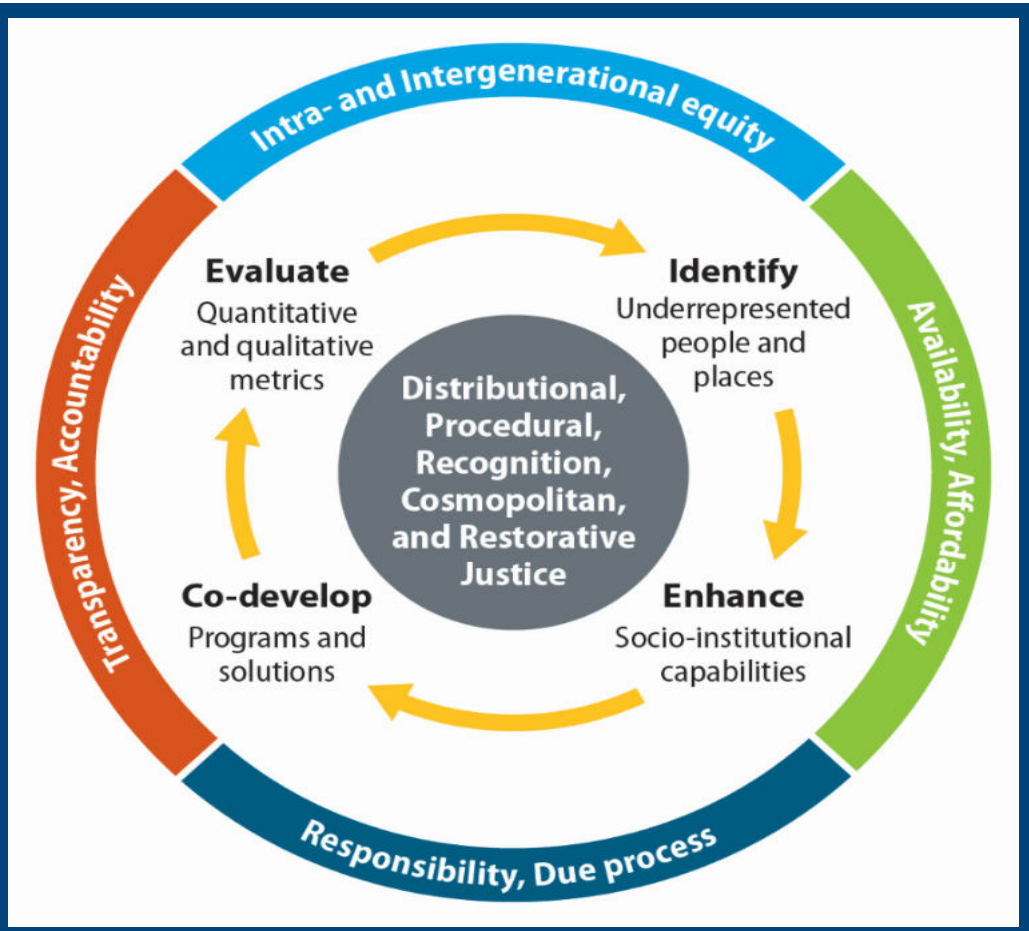
2. Whose needs and realities will be included or excluded
   - *Procedural justice*

3. How historic inequities are addressed within the innovations and interventions
   - *Recognition/Restorative justice*

Source: Romero-Lankao and Nobler 2021

Fostering Just Energy Transitions: Actionable Strategies

1. Use a palette of technical, social, cultural, and context sensitive solutions
2. Engage in inclusive processes to generate imaginative visions of the future
3. Actively pursue synergies with communities' priorities and values



An approach to move equity and justice from theory to practice. Source: Romero-Lankao & Nobler 2021

Metrics Guided by Energy Justice Principles

Energy Justice Tenet	Applied Principle	Metric
Distributional Equity	Affordability	Housing and Transportation Affordability Index score
Procedural Equity	Accountability	Participation in decision making committees
		Direct community relationships created
Intra- and Intergenerational Equity	Transitional workforce development	Number of programs, and enrollment levels, to cultivate business innovation
		Green job training programs in the community

Thank you!

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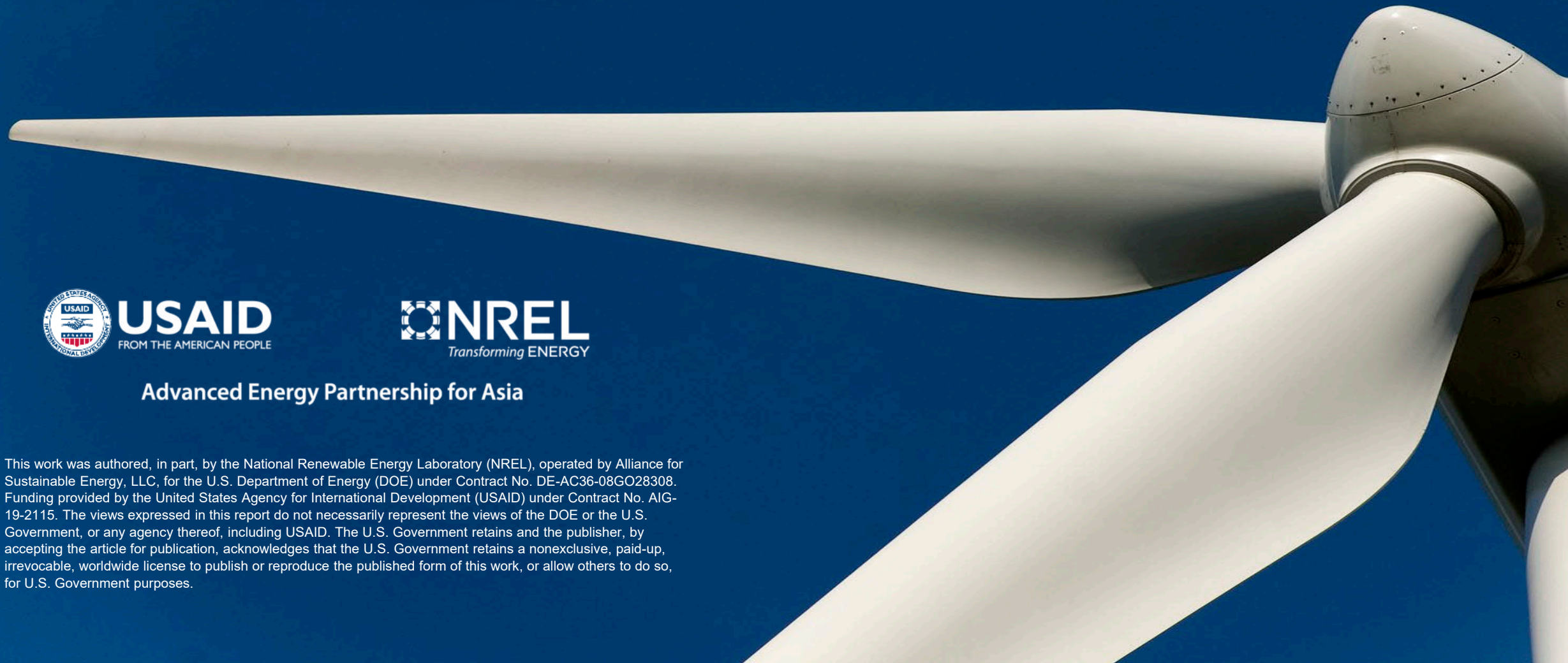

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Achieving NDCs through Power Sector Planning and Implementation - *Robust Analysis across Energy Systems*

High-Quality Data Development and Collection

Galen Maclaurin - June 18, 2021

Presentation Outline

1. Why is high-quality data important for decisions and what types of analysis can inform these decisions?

2. RE Data Explorer as one example repository for high-quality data and RE Explorer as a resource to understand how data can inform decisions.

3. Deeper dive on collection and development of high-quality solar data

4. Connection point between high-quality renewable energy resource data and grid integration analysis (presented by International Energy Agency)

High-quality Data for Decisions

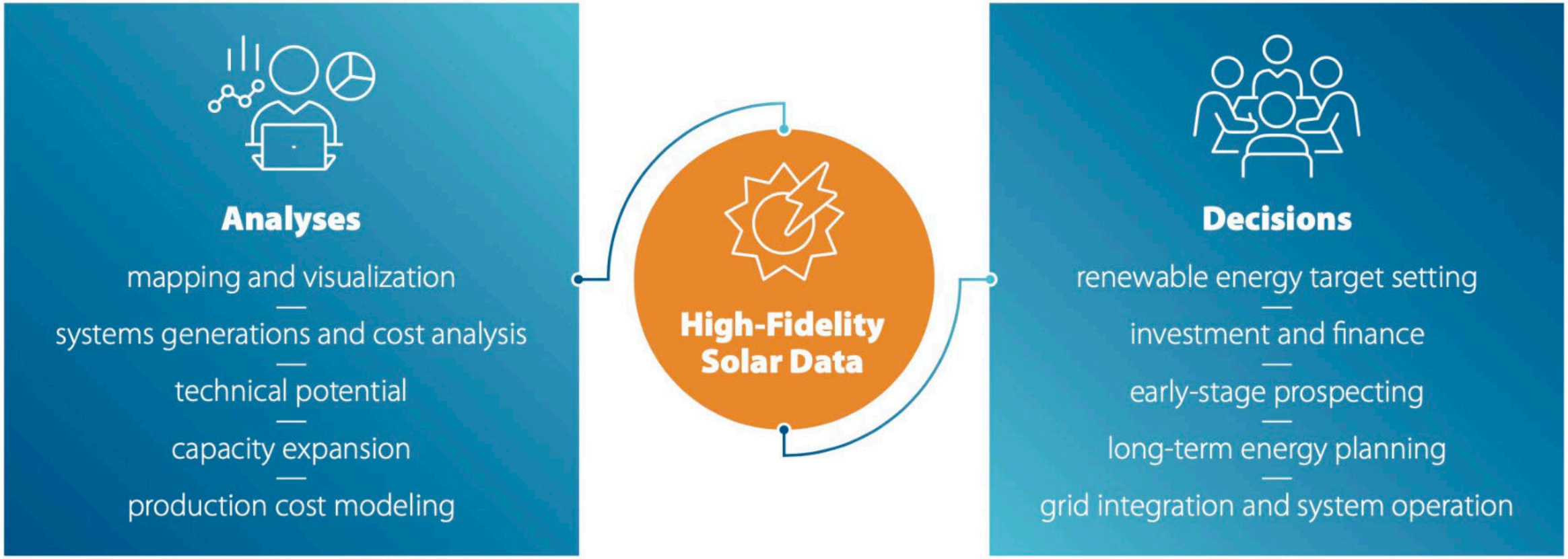
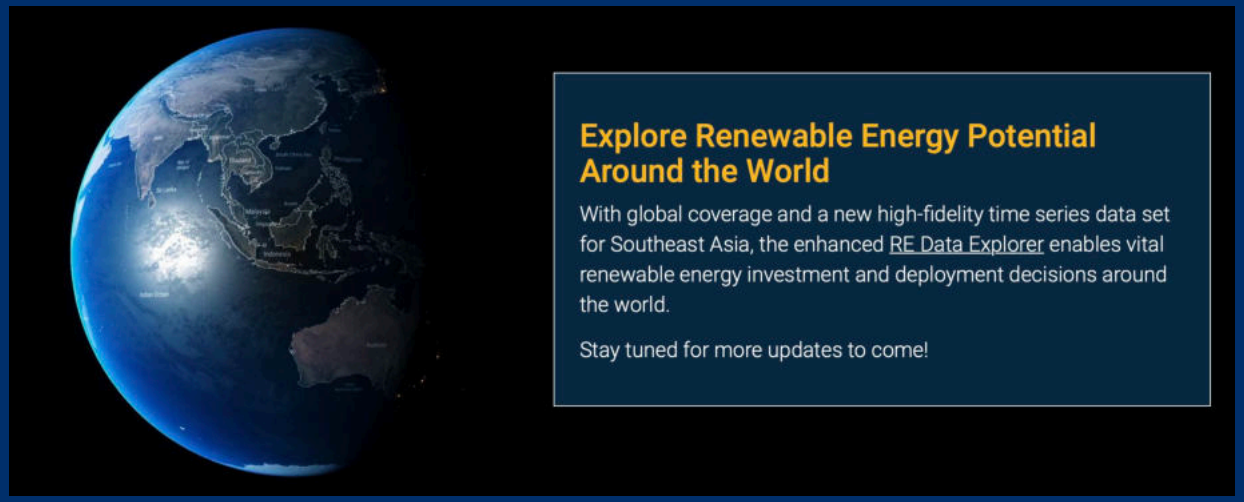


Figure 1. *High quality, reliable data are at the core of critical decisions to enable energy transitions.* *Image by Christopher Schwing, NREL*

Renewable Energy (RE) Data Explorer

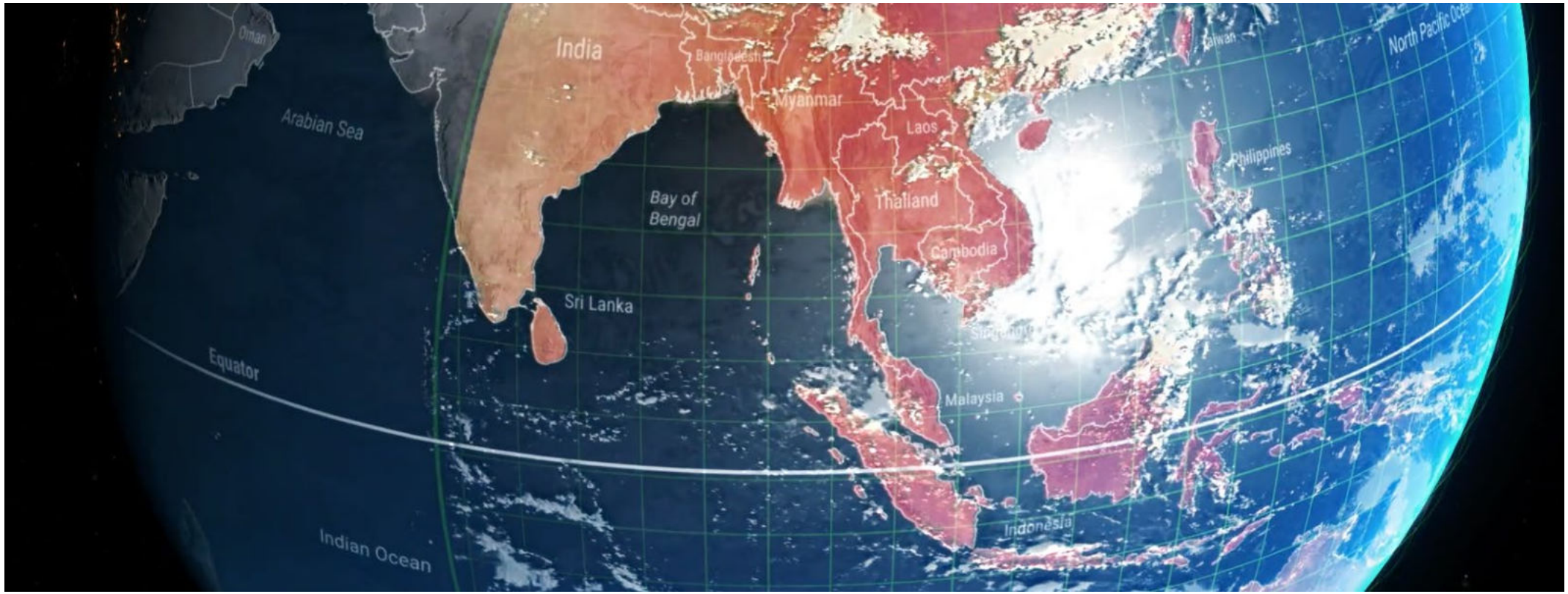
- A user-friendly geospatial analysis tool for analyzing renewable energy potential and informing decisions.



www.re-explorer.org

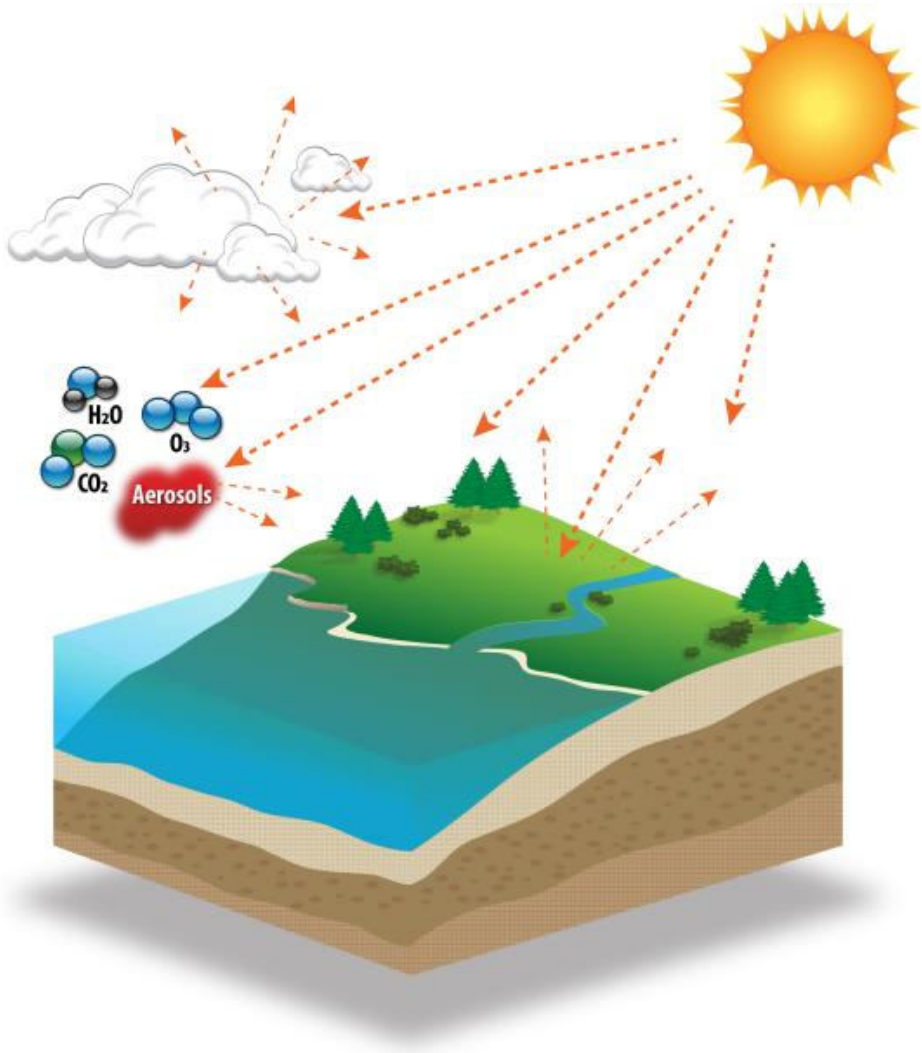
- Performs visualization and analysis of renewable energy potential that can be customized for different scenarios.
- Repository for download of high-quality data and integration with other analytic tools.
- Supports prospecting, integrated planning, policymaking, and other decision-making activities to accelerate renewable energy deployment.

Southeast Asia Solar Resource Data Development



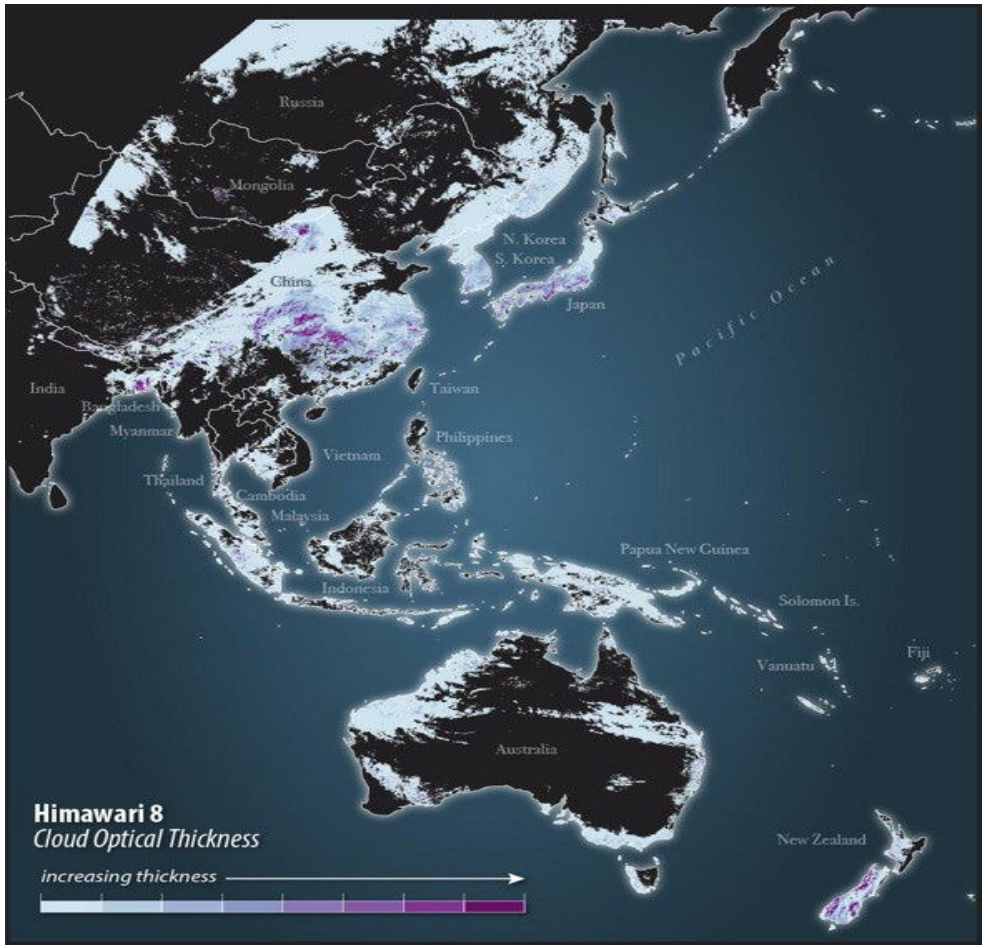
NREL's Physical Solar Model (PSM)

- Models the transfer of solar radiation through Earth's atmosphere
- Considers interactions with atmospheric constituents and land surface
- Characterizes absorption and scattering of solar radiation from clouds and aerosols



Himawari Solar Irradiance Data Set

- Cloud characteristics are a key input for the PSM to estimate absorption and scattering of the incoming solar radiation
- Imagery from the Japanese Meteorological Agency's (JMA) Himawari 8 satellite covers much of Asia and Oceania at 2km spatial resolution and at 10-minute intervals
- We partnered with the University of Wisconsin to model cloud type, thickness, and properties



Cloud optical thickness shown for April 1, 2019

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SE Asia Solar Data Development

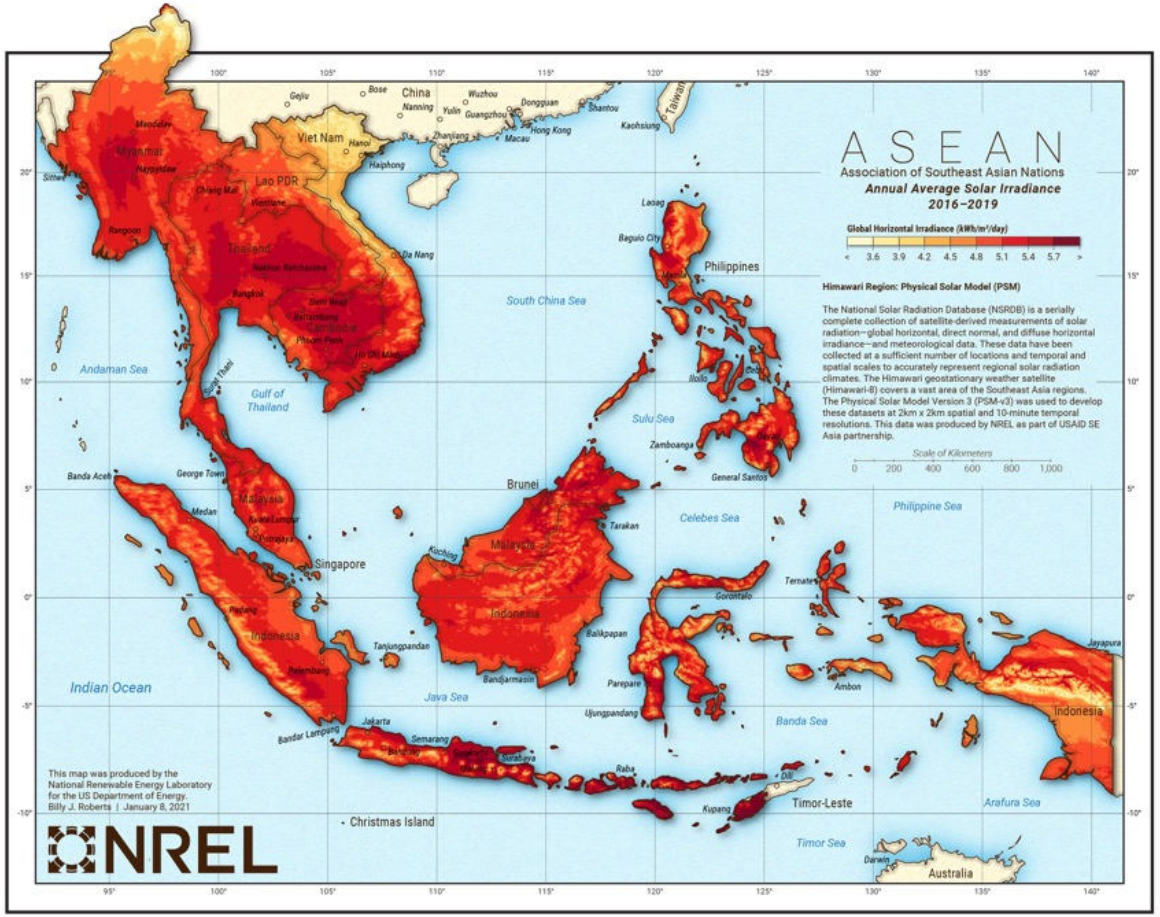

Figure. Global Horizontal Irradiance (GHI) shown

Harnessing the power of NREL's High Performance Computing system, we produced 5 years of high-resolution solar irradiance data along with ancillary meteorological variables required to model solar energy generation.

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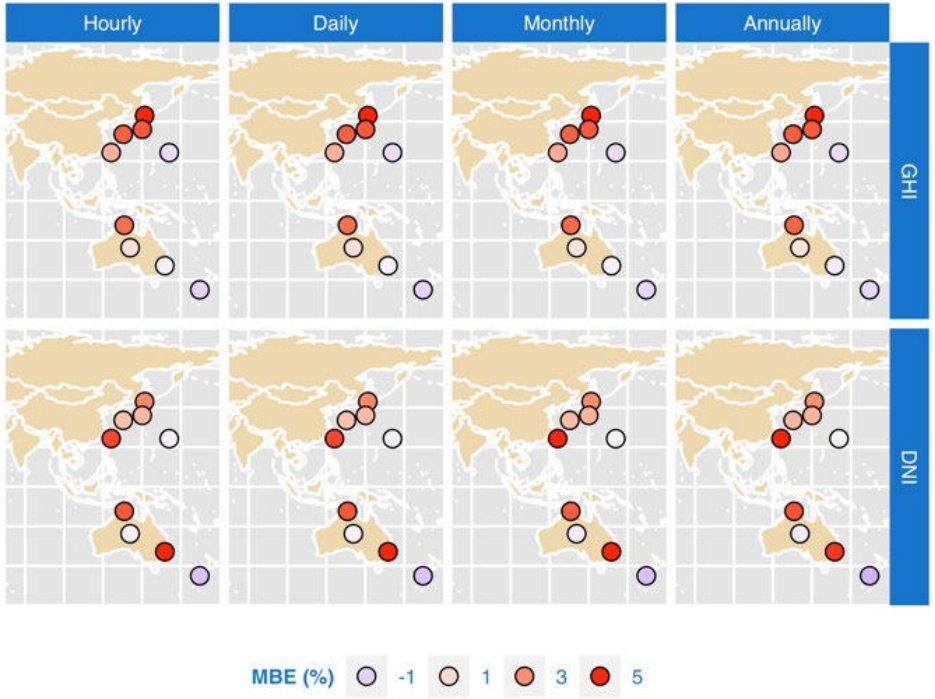
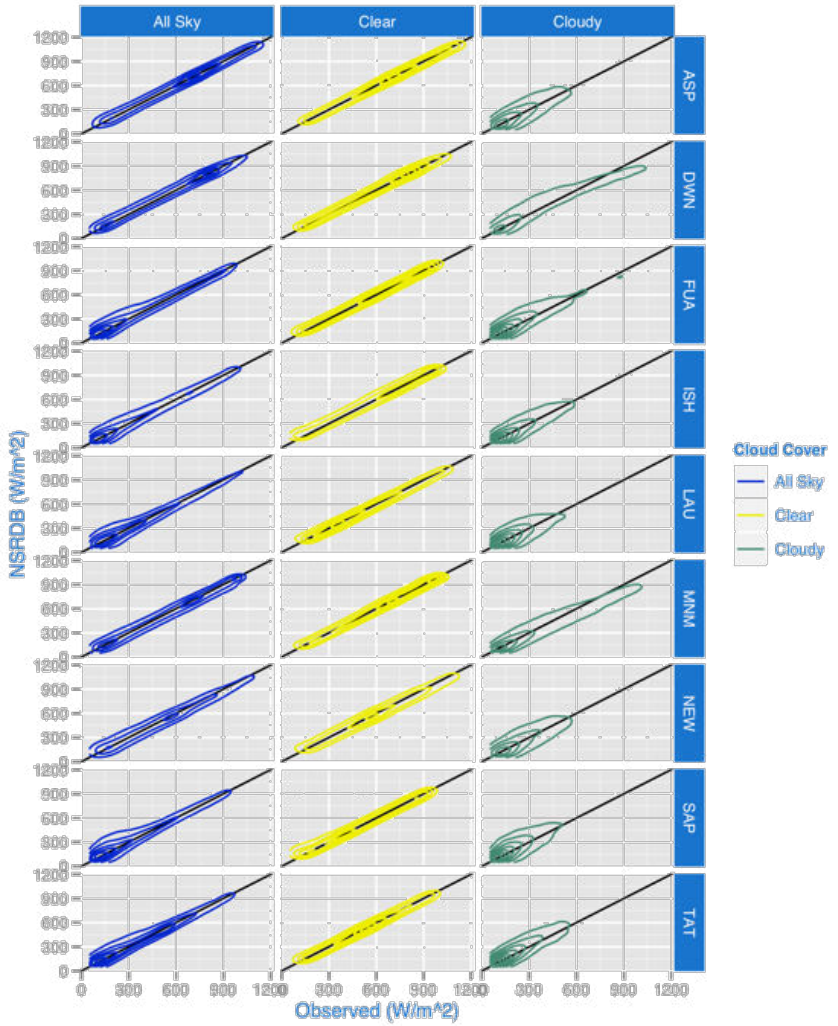
Model Validation

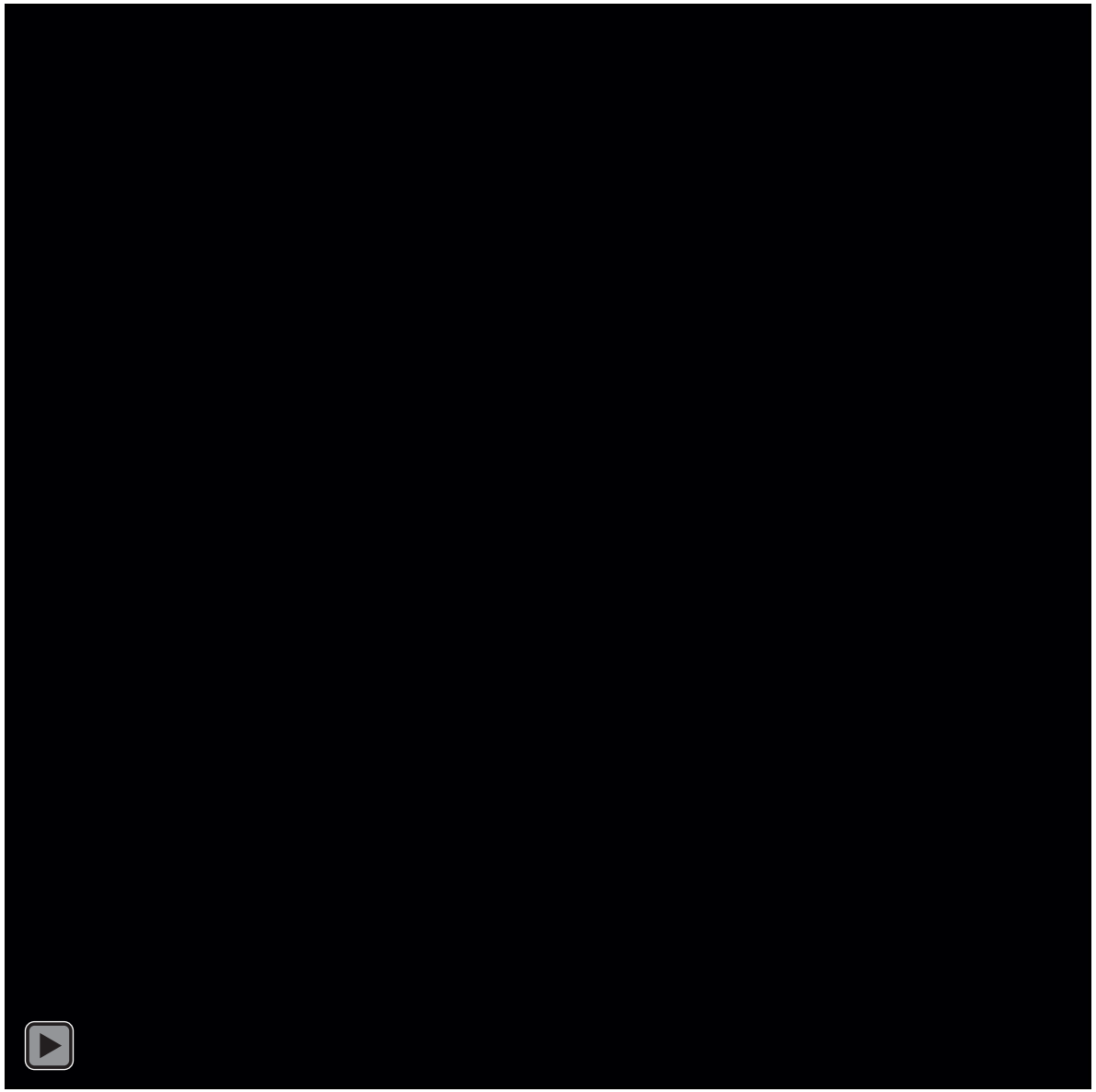




- Validation conducted using nine solar radiation measurement stations from the Baseline Surface Radiation Network (BSRN)
- Annual Mean Biases Error (MBE) typically less 5%

High-Resolution Time Series Solar Resource Data

The Result: Serially Complete Solar Irradiance and Meteorological Variables at 2km spatial and 10-minute temporal resolutions for 2015 through 2019



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High-quality Data for Decisions

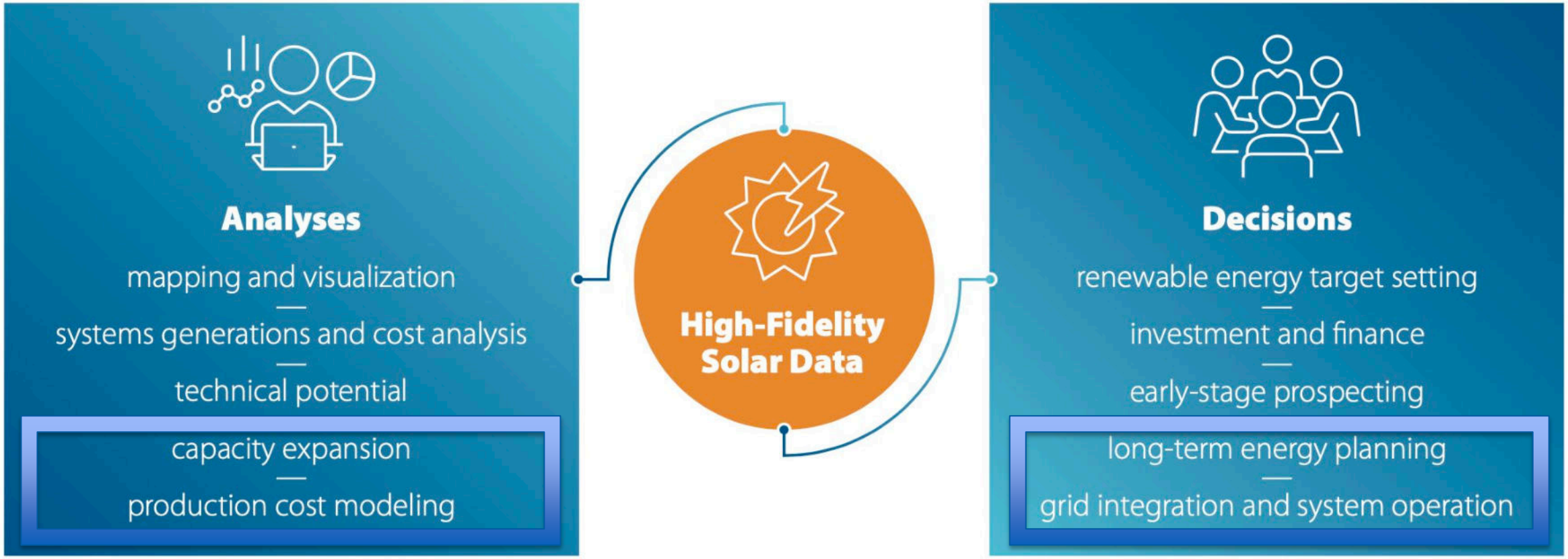
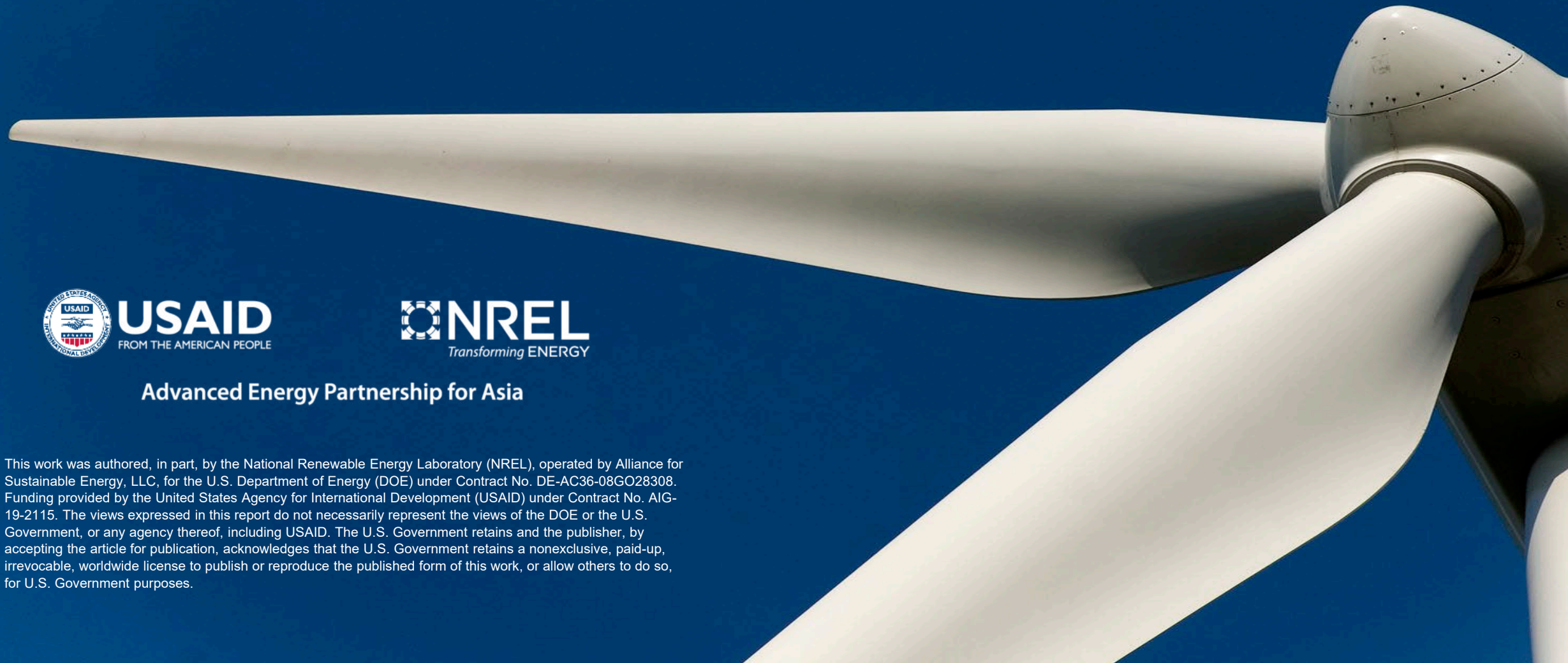


Figure 1. *High quality, reliable data are at the core of critical decisions to enable energy transitions.* *Image by Christopher Schwing, NREL*

Thank you!



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Achieving NDCs through Power Sector Planning and Implementation

16th Asia Clean Energy Forum

Renewable Energy Management Centres for Large-Scale Grid Integration of Renewable Energy in India

Sunil Kumar Sharma

June 18, 2021

India‘s NDC Targets

Under the Paris Agreement (2015), India’s Nationally Determined Contribution (NDC) target has three major dimensions:

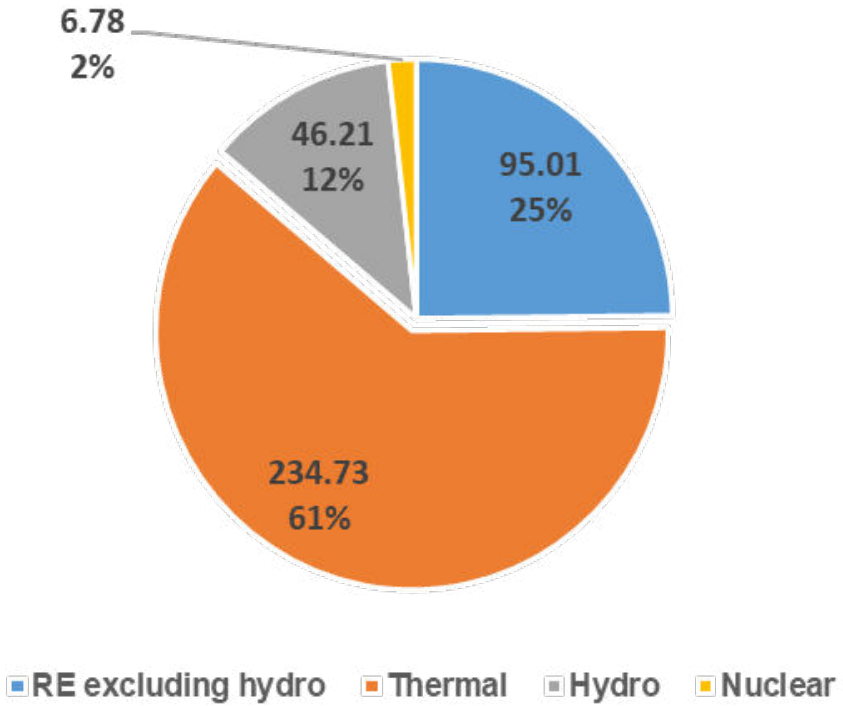
- **Reduce emission intensity of GDP by 33-35% from 2005 level by 2030**

- **40% installed power capacity from non-fossil sources by 2030**

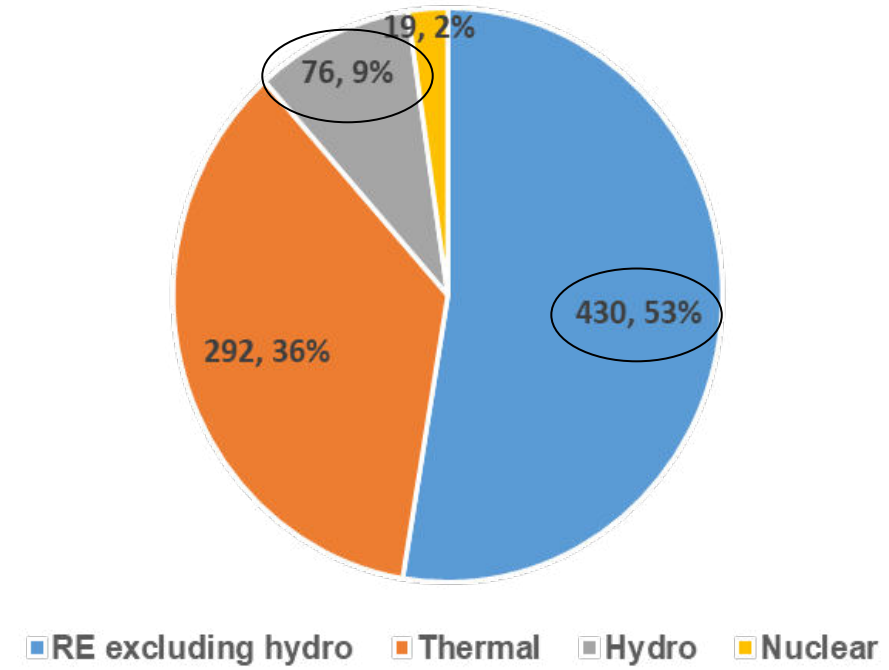
- **Additional carbon sink of 2.5 to 3 billion tons through afforestation**

Progress on NDC Target for Renewable Energy

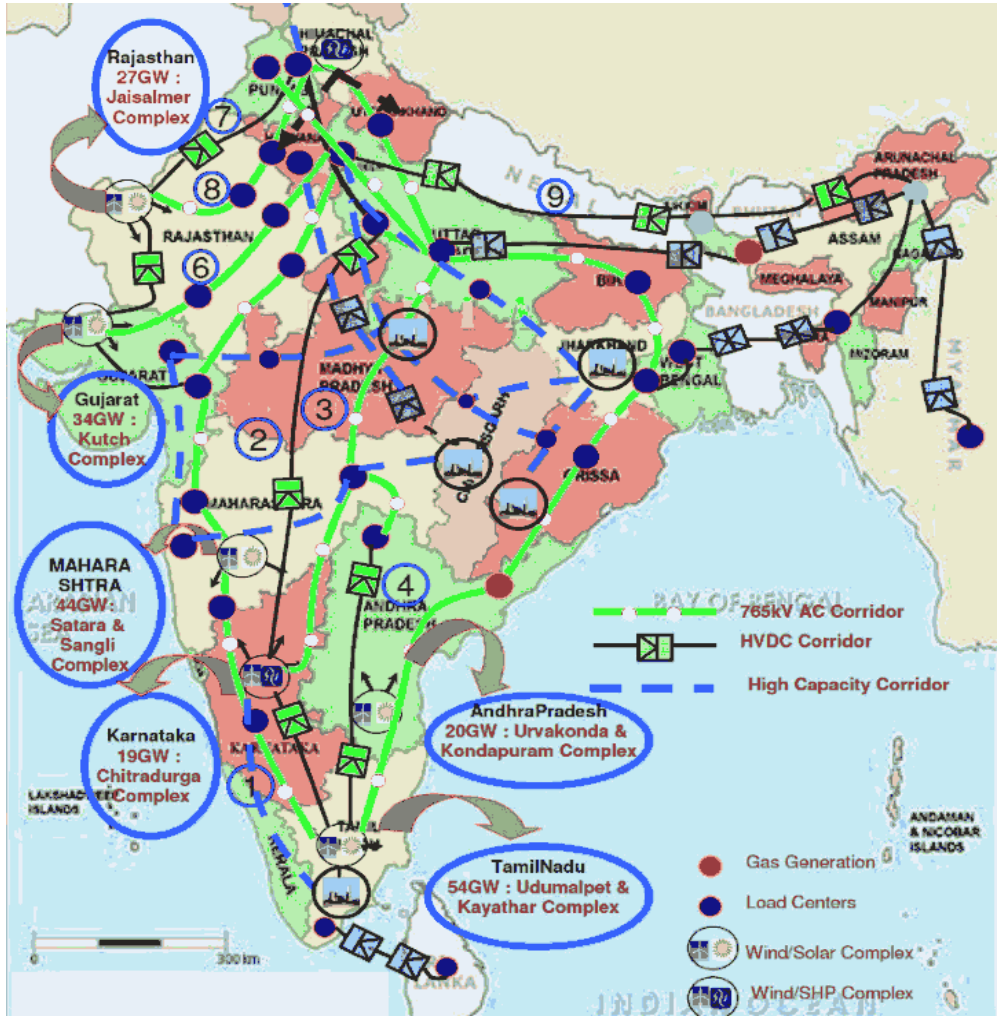
Installed Capacity (GW), April 2021 *(383 GW total)*



Projected Installed Capacity (GW), 2030 *(817 GW total)*



Source: Central Electricity Authority (CEA), India



Source: PGCIL, India

Green Energy Corridors (GEC)

Transmission Plans to Evacuate RE Generation

- Power Grid Corp of India released the first report on GEC to showcase the transmission network required to evacuate the planned RE capacity
- GEC 2 (2016): Focus on 20 GW solar park transmission
- Renewable Energy Management Centres (REMCs) were envisaged as control infrastructure under GEC planning

Green Energy Corridors

Current Implementation Status

- Inter-state Transmission
  - **Target capacity:** 3200 circuit kilometre (ckm) transmission lines and 17,000 MVA capacity sub-stations
  - **Current Status:** Completed in March 2020

- Intra-state Transmission (covering 8 renewable energy rich states in India)
  - **Target capacity:** 9700 circuit kilometre (ckm) transmission lines and 22,600 MVA capacity sub-stations
  - **Current Status:** Expected to complete in 2021

Source: Ministry of New and Renewable Energy (MNRE), India

Grid Operations: Role of Operational Planning

- Conventional load dispatch centre (LDC) operation → Forecast the load and generators will follow the load. With wind and solar generation, such is not the case
- Generation of power from wind and solar is highly dependent on weather conditions
- To deal with volatile, intermittent generation from smaller wind and solar plants, different skill set for operational planning and analytical tools are required
- With high injection from renewable energy sources into the grid, behavior of conventional generators will also change (*more flexibility required*)
- With Net Metered Solar Rooftop projects, E-Vehicles, and Demand Response (DR) measures consumers behaviors will also change

With increasing penetration of renewable energy, DR and EV grid operators require innovative, analytical tools and skill sets

Wind and Solar Penetration Levels

State	Wind and Solar Penetration (2018-19)	Maximum Daily Energy Penetration of Wind and Solar	Maximum Instantaneous Penetration of Wind and Solar
Karnataka	23 %	56 %	90 %
Tamil Nadu	13 %	38 %	48 %
Andhra Pradesh	21 %	51 %	71 %
Gujarat	11.6 %	33.2 %	39.5 %
Maharashtra	5.7 %	18 %	23 %
Madhya Pradesh	8.7 %	30 %	42 %
Rajasthan	14.2 %	34 %	50 %
Western Region	8.3 %	20 %	24.2 %
Southern Region	15 %	30 %	47 %
All India	**8 %**	**15.1 %**	**19.4 %**

Source: Presentation by POSOCO in 2nd International Conference on RE Grid Integration in India ***2019 India - Int'l Conference on Large-Scale Grid Integration of Renewable Energy in India (regridintegrationindia.org)***

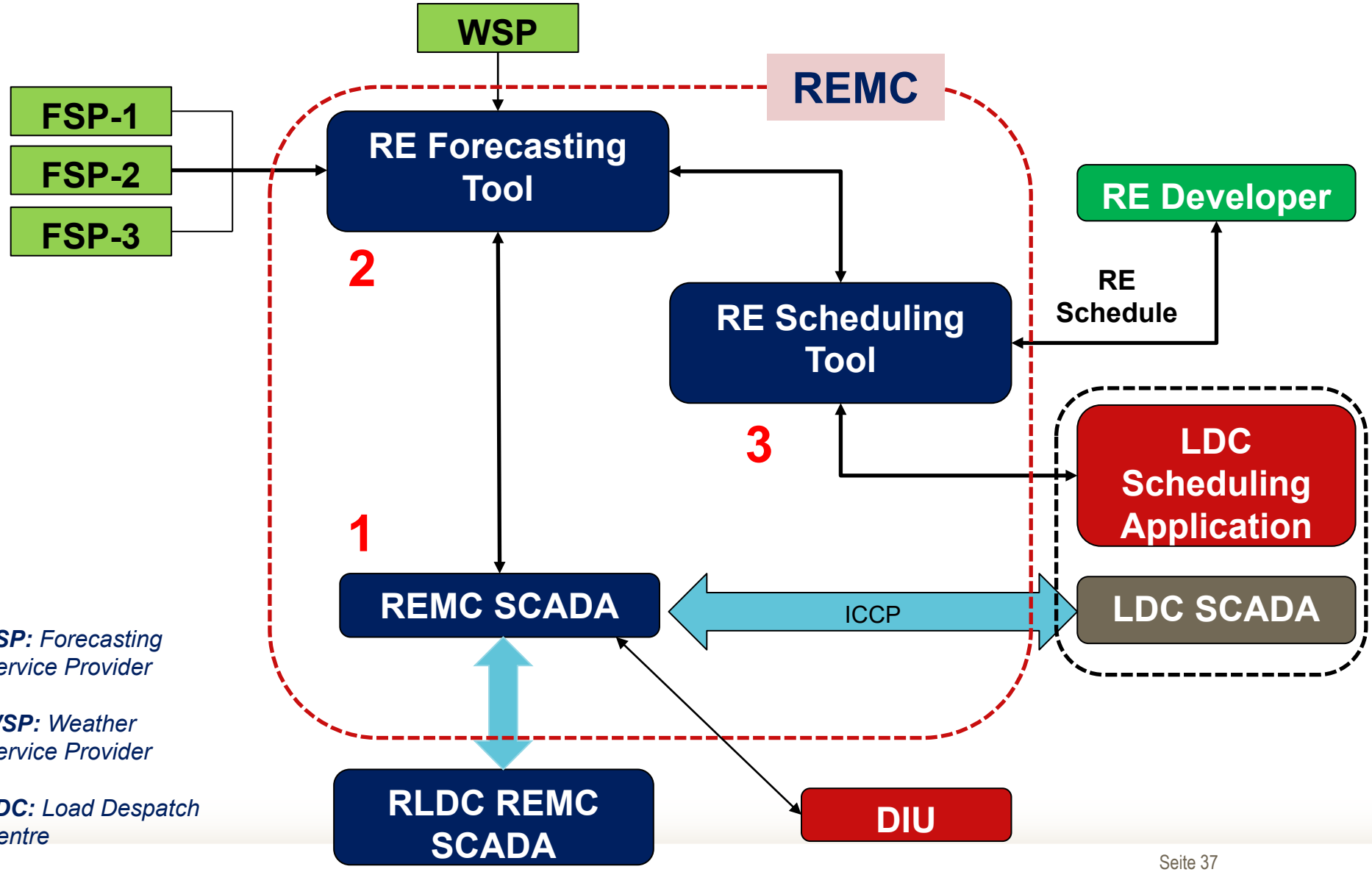
Increasing wind and solar penetration has to be managed using advanced tools and analytics

Concept of REMC

Renewable Energy Management Centre (REMC), co-located with xLDC, provides the grid operators with state-of-the-art tools to integrate renewable energy generation in its control area. Major functions include:

- **Forecasting** of wind & solar generation (day(s) ahead, intra-day, etc.)
- Online geospatial **monitoring** of renewable energy generation – at the transmission grid boundaries & at renewable energy pooling stations
- Responsible for providing **reliable renewable energy data** (renewable energy generation, forecasting and scheduling data) to the xLDC; dedicated **renewable energy scheduling tool**
- **Central repository** for renewable energy generation data (for future data analytics applications)
- **Coordination agency** on behalf of xLDC for interacting with renewable energy developers

REMC Architecture



FSP: *Forecasting Service Provider*

WSP: *Weather Service Provider*

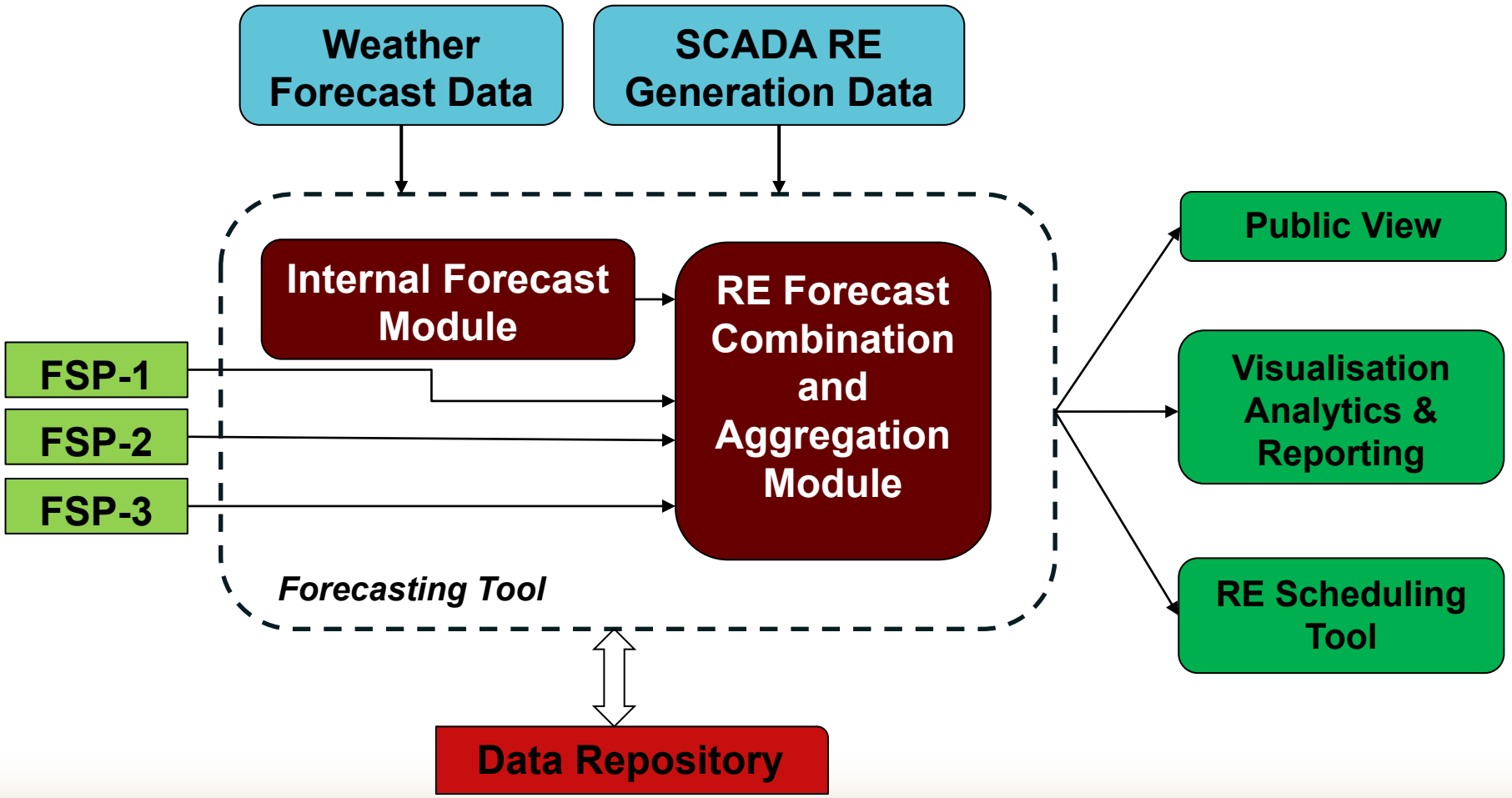
LDC: *Load Despatch Centre*

Need of Renewable Energy Generation Forecasting

- Dependence on weather conditions: wind and solar power generation is highly dependent on weather parameters.
- Mainstreaming of renewable energy generation: wind and solar are no longer minor generators. By 2022, the penetration of renewable energy is expected to increase to ~20% (in consumption).
- Limited control reserves in India: make it more difficult for grid operators since very limited control reserves available for real time frequency control
- Scheduling of renewable energy: For improved off-take of renewable energy generation, hence, no curtailments
- Grid security: Forecasting and scheduling from renewable energy generators lead to better grid discipline
- For load despatch centres: To ascertain the balancing requirement on day ahead and intra-day basis

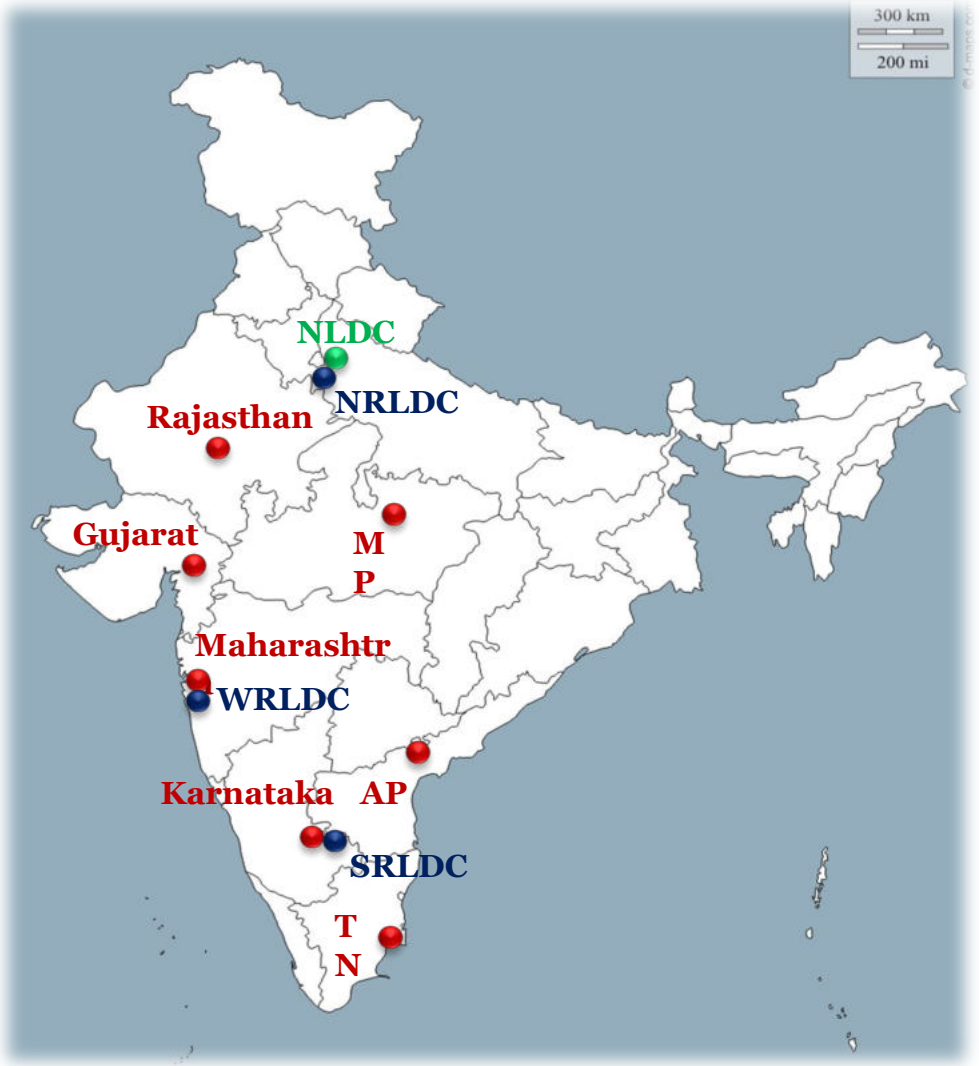
Renewable energy forecasting is one of the least cost solution to integrate high amount of renewable energy in power system.

FORECASTING MODULE: Schematic Diagram



WHERE: *To Begin With…*

- Concept and DPR for REMCs were developed by GIZ under Indo – German Energy Program (IGEN – GEC)
- Establishment of 11 Renewable Energy Management centers (REMC) across India
  - Seven renewable energy resource rich states
  - Three regions: South, west and north
  - National REMC at NLDC



Status of REMC Implementation

- **Funding:** All the 11 REMCs are funded via Indian Ministry of Power grant (including forecasting services for the first 4 years)

- **Implementing Agency**: PGCIL is the implementing agency. Post implementation REMCs work with respective load despatch centres.

- All the 11 REMCs are ready and started operations in 2019-20.

Conclusion and Way Forward

- REMCs in India are expected to manage >60 GW vRE (wind + solar) capacity by 2021
- Accuracy of renewable energy generation forecast improves with time due to continuous model training and data analytics capabilities
- All state load dispatch centre in India should implement REMCs
- Accurate (net) load forecast is as important as renewable energy generation forecast
- Forecasting of generation from solar rooftop systems will become important (40 GW target). First step is to have static database of installed capacity
- Skill upgradation

Thank You!

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CLEAN ENERGY INVESTMENT ACCELERATOR

The Clean Energy Investment Accelerator in Southeast Asia

Marlon Apanada
Country Lead – Philippines, CEIA &
Southeast Asia Engagement Lead, WRI

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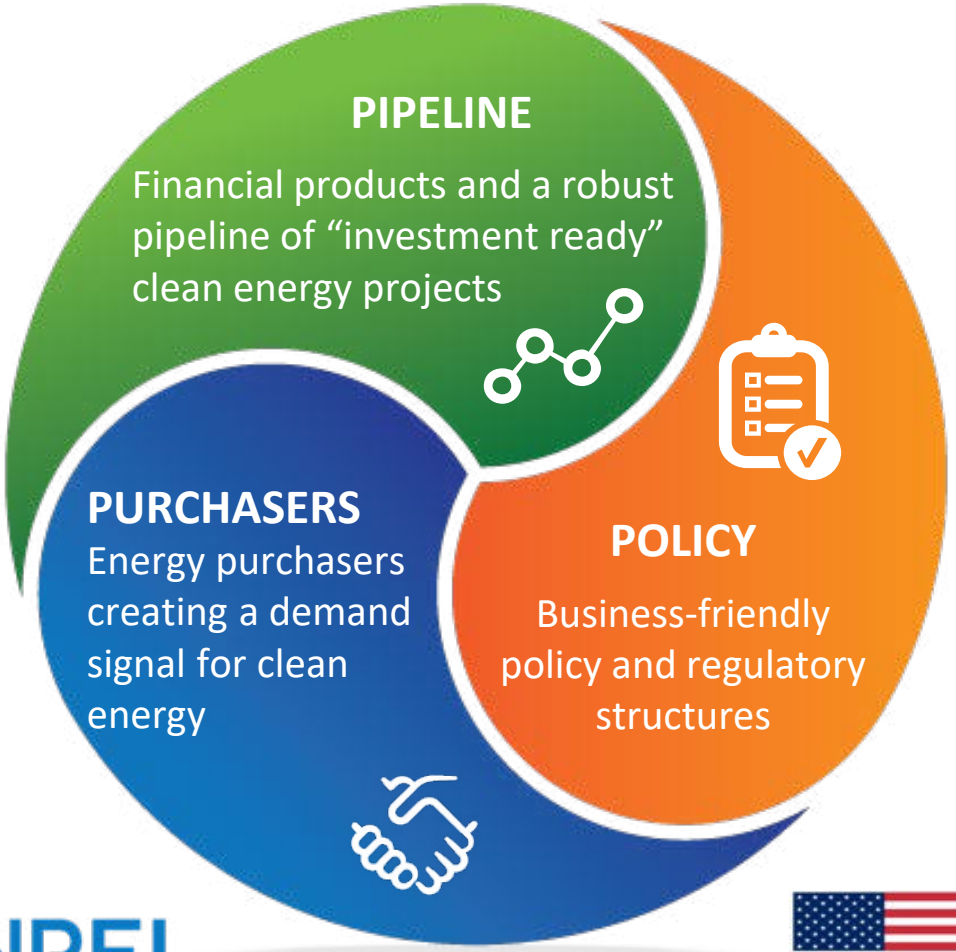
The Clean Energy Investment Accelerator (CEIA)

is an innovative public-private partnership that addresses barriers to clean energy deployment in the commercial and industrial sectors in emerging markets.

- The CEIA has been jointly implemented by **WRI, NREL, and Allotrope Partners** since 2016, through the leadership of global and in-country teams.
- CEIA currently conducts deep-dive efforts in **Colombia, Indonesia, Mexico, Philippines, and Vietnam.**
- CEIA also supports r**egional and global replication** through a coalition of partners, including the Low Emission Development Strategies Global Partnership.



Work centers on three essential pillars for overcoming barriers by supporting: an enabling policy environment, increased private sector clean energy investment, and transformational business models for scaled deployment.

CEIA is supported by a range of public, private, and philanthropic partners, including:

The Power of Private Sector to Drive Energy Transformation

- ***Private sector investment is essential to achieving enhanced NDCs:***
  - Public sector spending alone cannot support the level of investment needed to achieve country goals and deep decarbonization.
  - Many utilities in emerging markets are in precarious financial situations and unable to obtain sufficient capital to expand capacity at pace with rapidly growing energy demand.

- ***The private sector can play a powerful role in driving NDC progress and raising ambition by:***
  - Piloting innovative approaches that can be scaled across sectors.
  - Attracting new investment from a growing ecosystem of clean energy financiers.
  - Promoting aligned policies to diversify clean energy purchasing options and green a country's energy mix in line with international RE procurement principles.

CEIA's Unique Value Add

1. CEIA turns private sector commitments into in-country progress
2. CEIA addresses a gap that is not independently filled by the private or public sector
3. CEIA proves the business case for first-in-kind transactions that have the power to move markets

Building Back Better from COVID-19: Enabling Sustainable Economic Recovery

The Need for CEIA:

1. Globally $10 trillion economic stimulus opportunity to enable sustainable recovery.
2. Public budgets alone are not sufficient for recovery at the levels needed in target markets, thus private investment will be critical.
3. Alternative business voices can inform recovery strategies and drive green growth.

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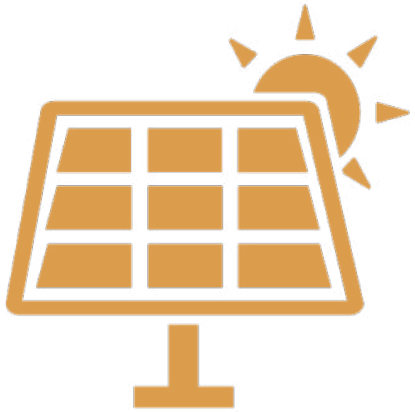
Global Impact Snapshots

100 public and private institutions with increased capacity to scale clean energy

Over 2,500 people trained

12 renewable energy policies strengthened across 5 countries



Deep technical support for 50 MW project pipeline

Over 1 GW of clean energy demand identified among partners

Market Transformation Progress

With support from CEIA and others, Vietnam's rooftop solar market is booming, increasing more than 2000% from less than 20 MW in early 2019 to 470 MW in early 2020.

After feedback from CEIA and partner companies, Indonesia announced a critical regulatory change that is expected to improve the economics of rooftop solar projects, lowering the capacity charge for industrial users to 1/8 of its previous level.

With CEIA support, a suite of improved policies are creating new opportunities for buyers and utilities, including Renewable Portfolio Standards, Net-Metering revisions, and a Green Energy Option Program (GEOP).

CEIA Impact Snapshots

Over 400 companies actively engaged in CEIA in-country coalitions

Local teams build on-the-ground partnerships & develop deep, market-specific expertise

16 clean energy policies strengthened across 5 countries

Deep technical support for 50+ MW project pipeline

2+ GW of clean energy demand identified among partners

Purchaser-Partnership Prioritization

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PURCHASERS

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CEIA Progress to Date

- ***Vietnam***: Expanded our **Vietnam Working Group** to a coalition of **more than 120** corporate buyers, developers, and government officials. Working Group members have participated in hundreds of MWs of new projects as buyers, sellers and investors.
- ***Philippines***: Brought together **city and business leaders** in the **City of Santa Rosa** to share cost-saving procurement pathways.
- ***Indonesia***: Grew **CEIA's Indonesia Working Group** to a coalition of more than 30 major companies like Nike, H&M, and Unilever. Held first-in-kind public-private dialogues where corporate buyers shared challenges with government and PLN.

RE Project Pipeline Support & Corporate Engagement

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PIPELINE

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CEIA Progress to Date

- ***Vietnam:*** Provided **deep technical support for first-in-kind pilot projects** with a major textile supply manufacturer (9.1 MW), an industrial zone with scaled ambition (2.1 MW), and a prominent retail chain to bring solar solutions to 12 sites across Vietnam (10.3 MW).
- ***Philippines***: CEIA is partnering with a major automotive company to support technical analysis and aggregated clean energy solutions for its 89 suppliers and 71 dealers.
- ***Indonesia***: Deepening engagement with **supply chain partners, industrial estates, and special economic zones** to develop new business models for renewable energy procurement.

CEIA Policy Engagement

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POLICY

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CEIA Progress to Date

- ***Vietnam***: Worked with USAID V-LEEP and dozens of leading companies to inform a first-of-its-kind Direct Power Purchase Agreement (**DPPA**) pilot program for 1,000 MW+ of clean energy.
- ***Philippines***: CEIA has partnered with policymakers to inform the Philippine energy transition and implementation of key policies, including: Renewable Portfolio Standards (**RPS**), Green Energy Option Program (**GEOP**), and upcoming auctions.
- ***Indonesia:*** Shared private sector insights with government on major barriers. Inputs from CEIA and others resulted in a revised regulation to reduce a capacity charge that significantly improves solar project economics for industrial energy users.
  - CEIA has **provided assistance to PLN** to **design and launch a REC program** to facilitate cleaner energy transactions and to inform improved green energy products to meet corporate buyers' needs.

Knowledge Products and Tools

Written Knowledge Products

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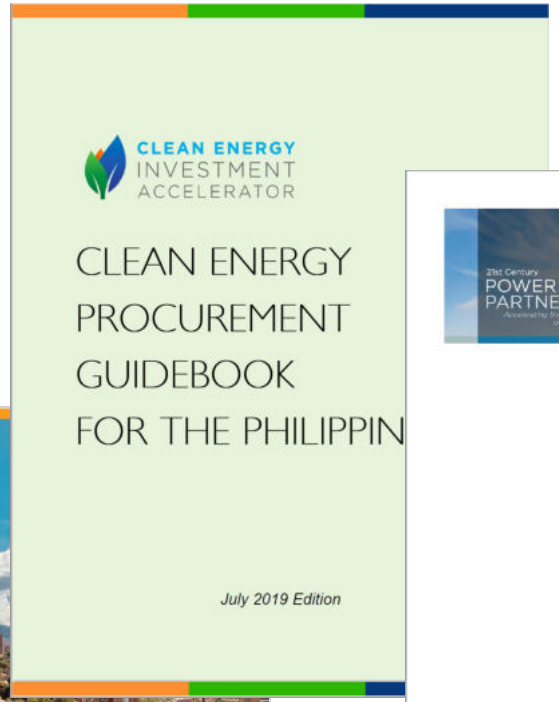
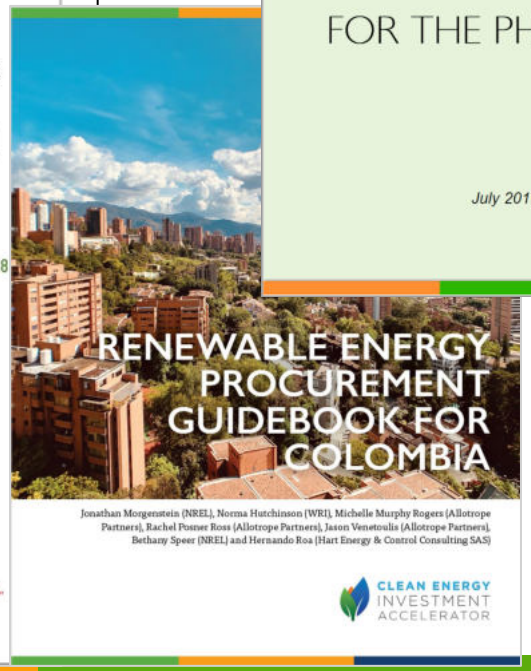
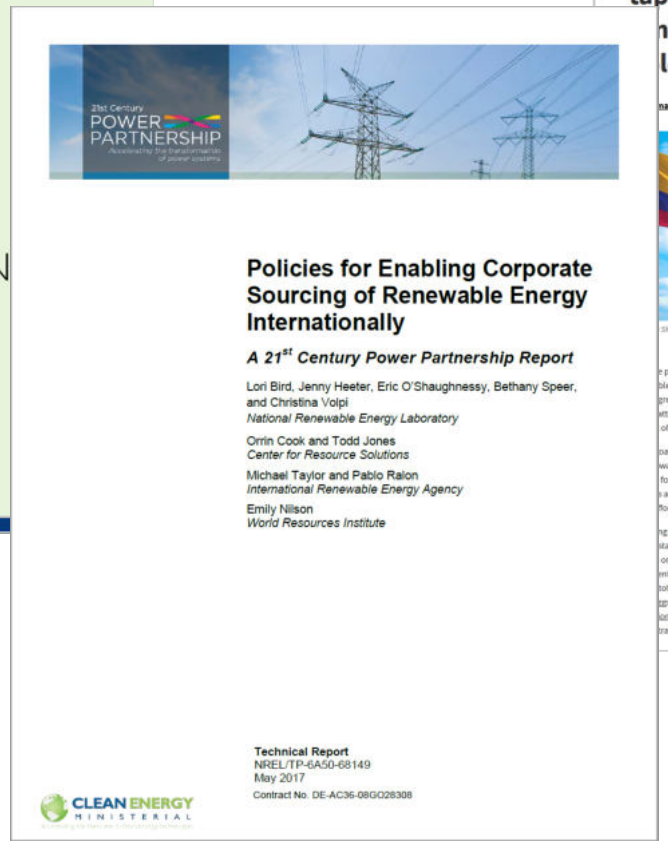
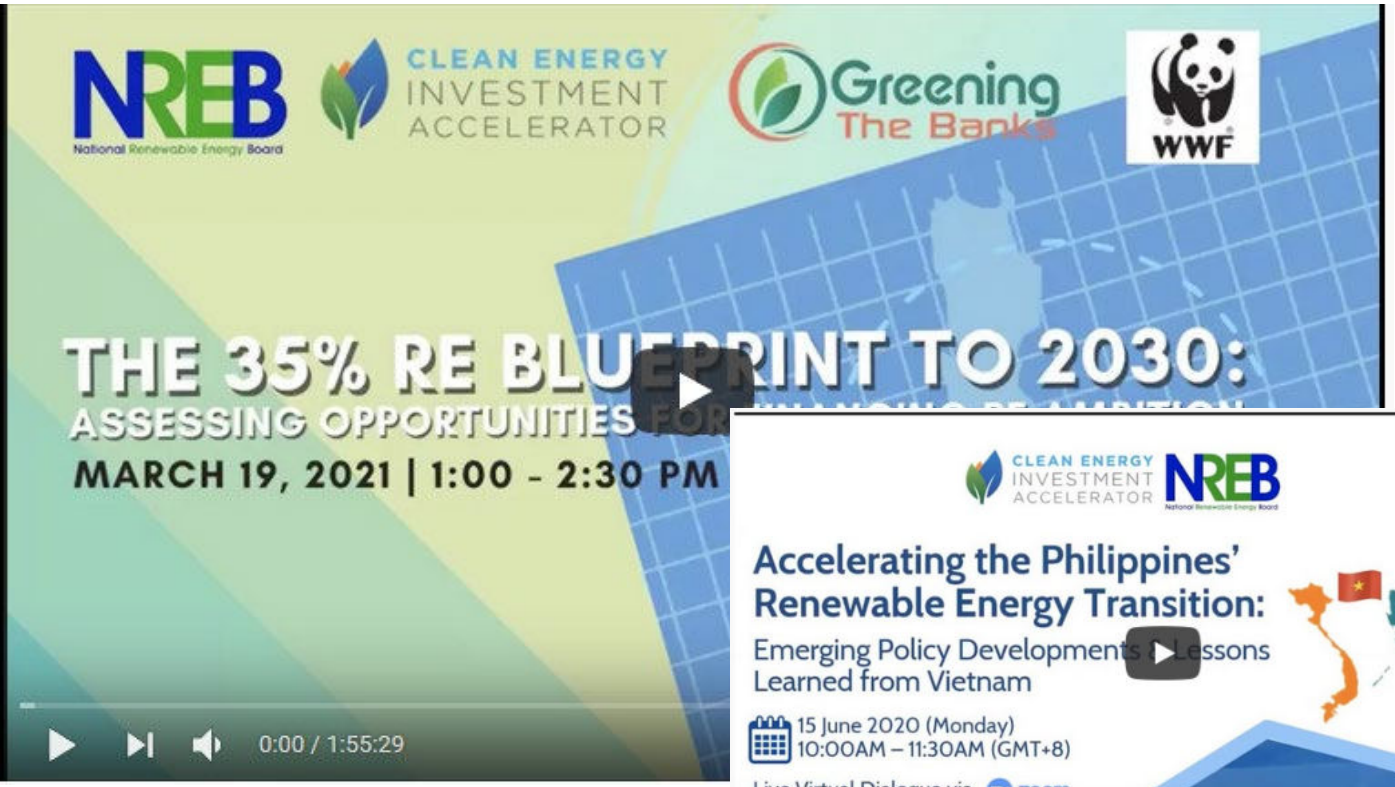






Virtual Dialogues



CEIA-NREB Webinar: Accelerating the Philippines' Renewable Energy Transition & Lessons from Vietnam

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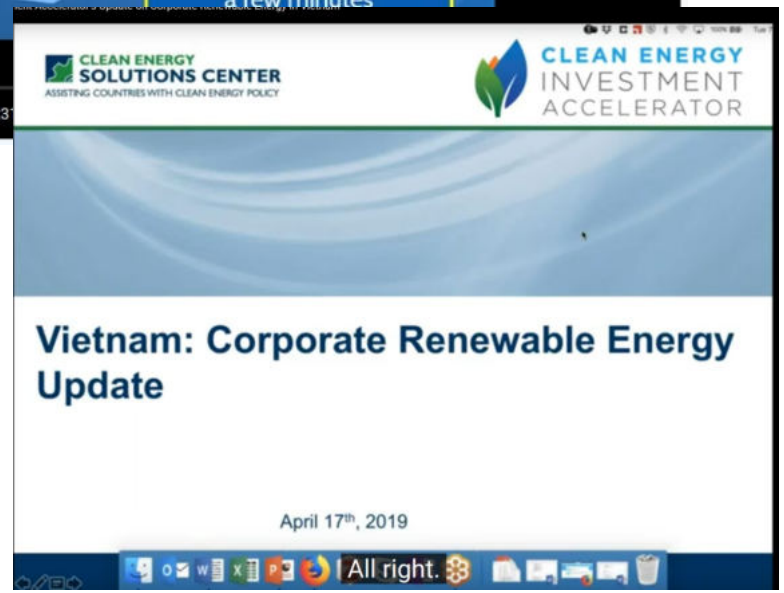

Thank You!

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Thank you!

Discussion and Q&A

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