International Energy Agency

Power System Flexibility in International Context

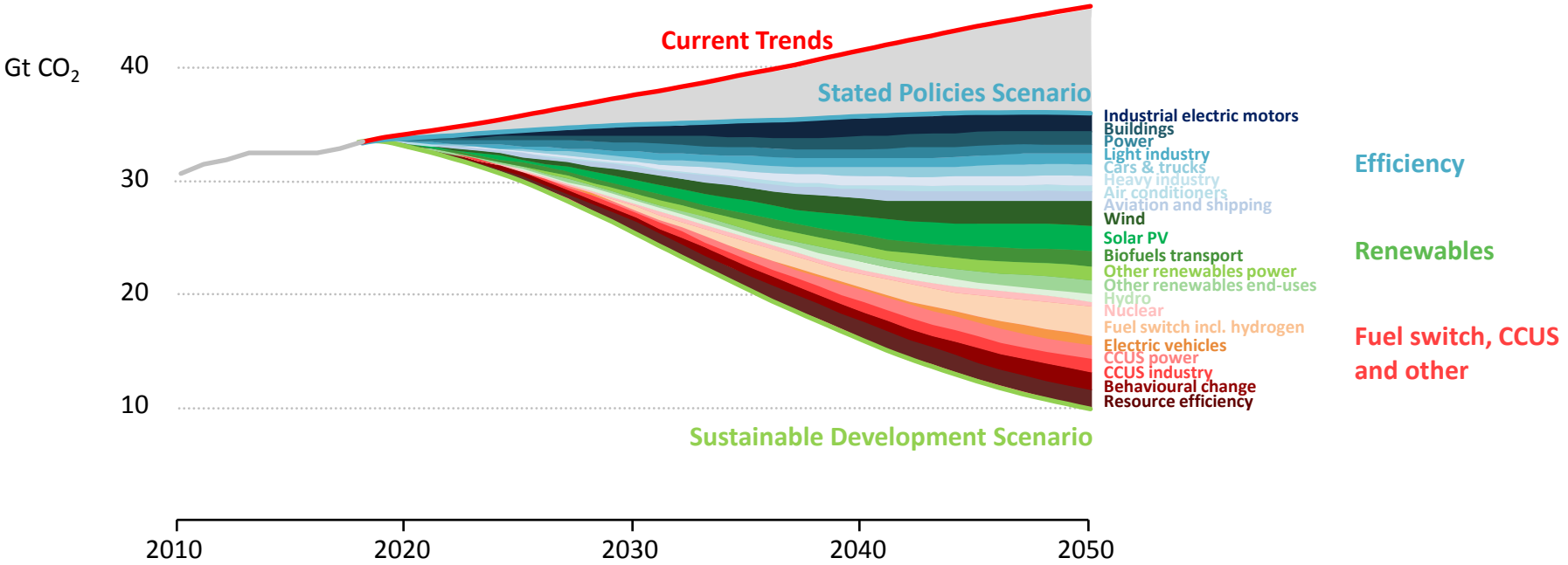
Szilvia Doczi – Renewables Integration and Secure Electricity

7 October 2020

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Global view: IEA World Energy Outlook Scenarios: Stated vs Sustainable

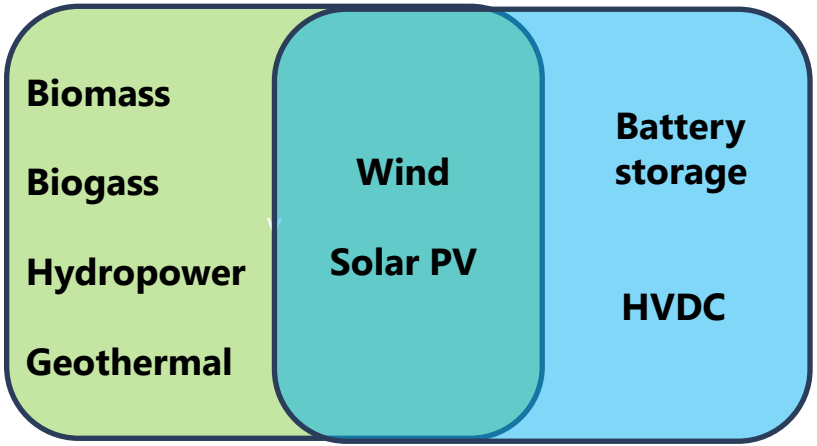
Energy-related CO_2 emissions and reductions in the Sustainable Development Scenario by source

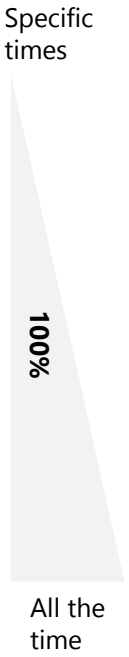


The current global energy path is not sustainable. Renewables plays a key role in securing a more sustainable energy future, alongside energy efficiency and others such as storage.

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RE versus VRE and high shares of VRE



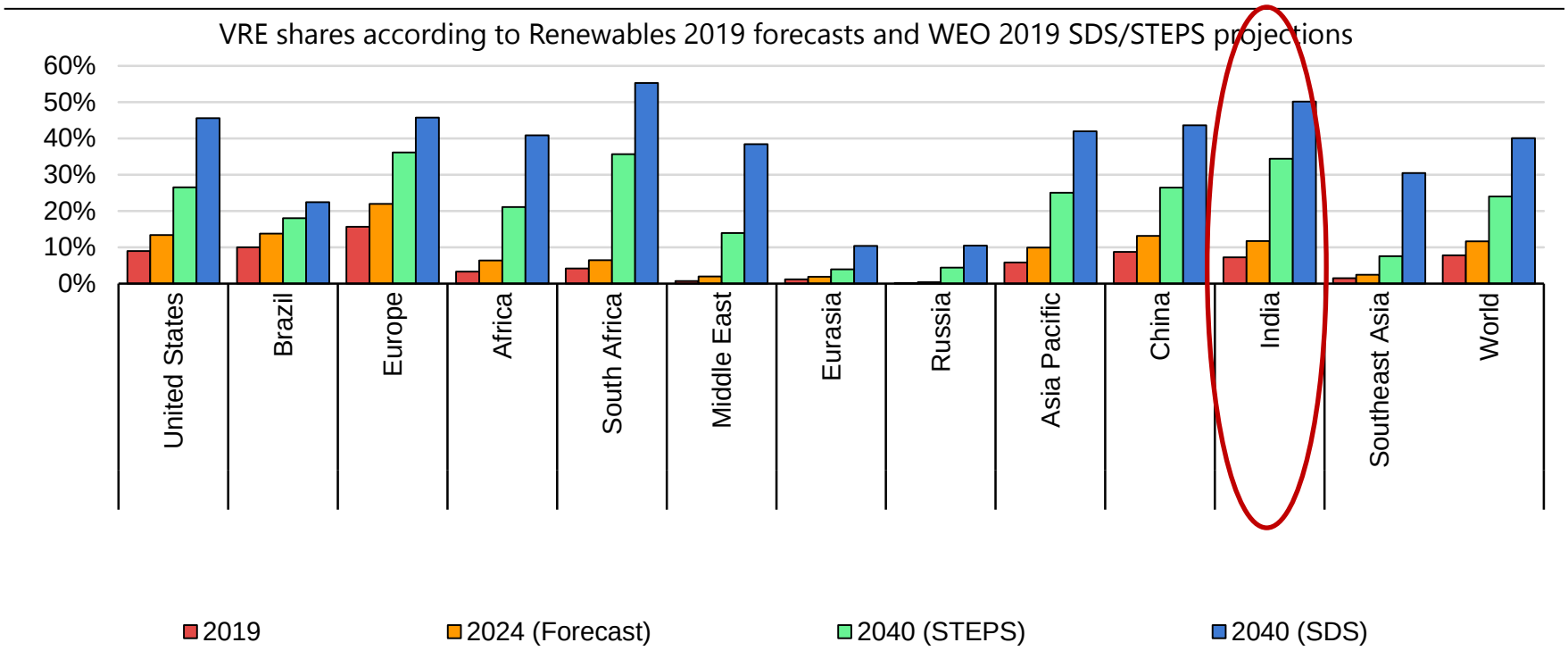


- 100% RE: Hydro (and geothermal) dominated systems exist that come close to 100% (e.g. Brazil, Costa Rica, Iceland, Lithuania, Norway)
- 100% VRE: massive PV and wind deployment exists in some regions
- 100% Inverter based: Batteries. and HVDC are interfaced via inverters, in addition to solar PV/wind.
- 100% at a given point in time, at day level, at year level?
- **WEO SDS of 40% PV/wind implies many regions with many hours of 100% VRE infeed**

IEA RE integration work focusses on the role of VRE and how the share of VRE increases in the power systems. Well before 100% is in reach we see important challenges internationally.

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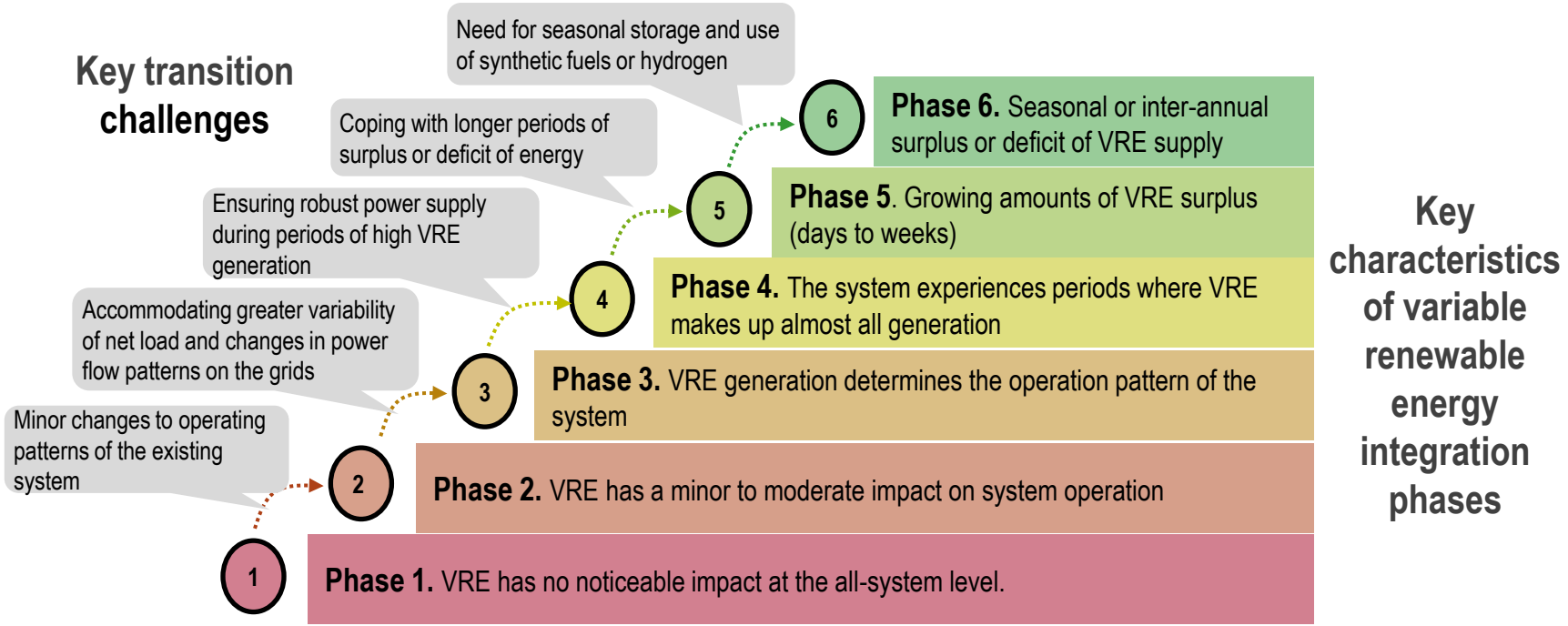
How VRE can increase around the world?



More countries are expected to deploy higher shares of renewables under WEO-2019 projections – including many emerging economies

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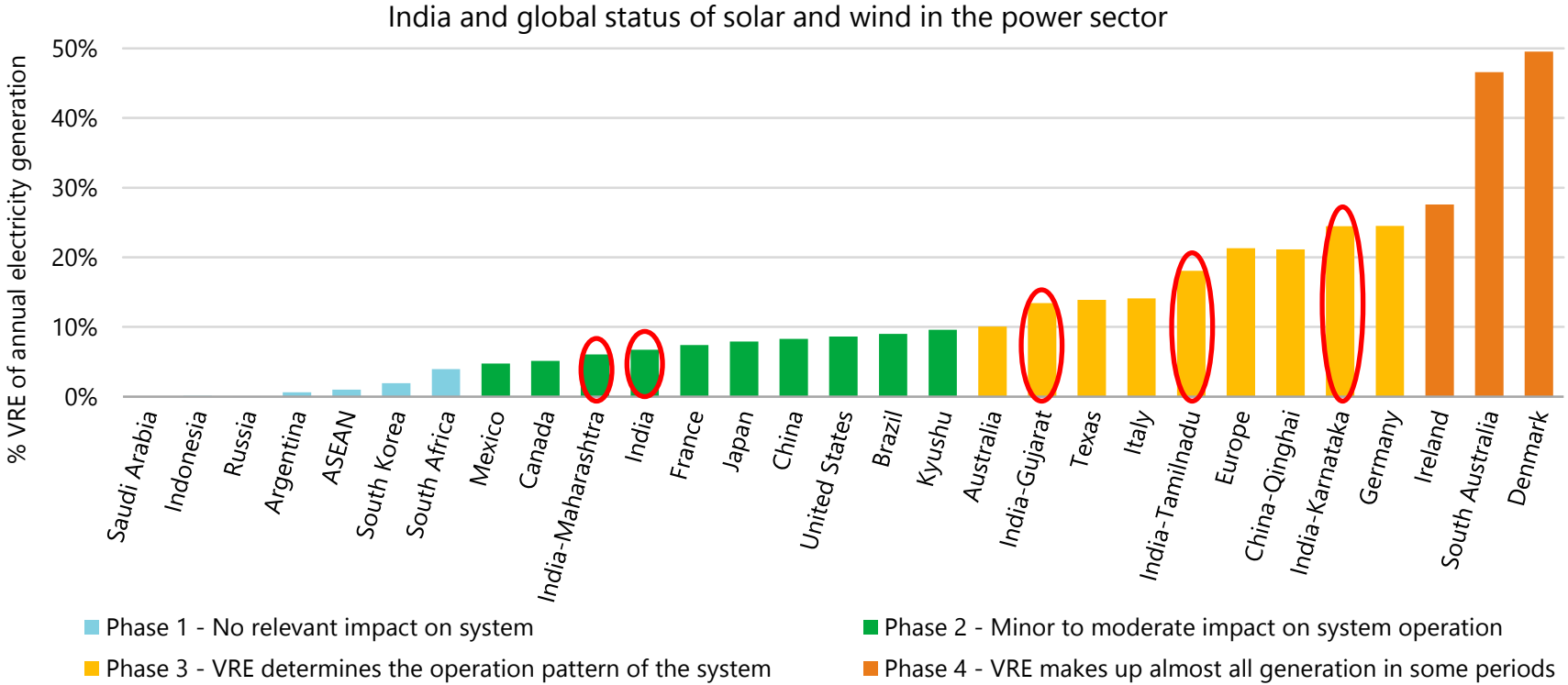
Six phases of system integration help make international comparison



Key challenges in each phase that should be addressed for moving up to higher phases of variable renewable energy (wind and solar) integration

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Solar and wind & Phases internationally vs India

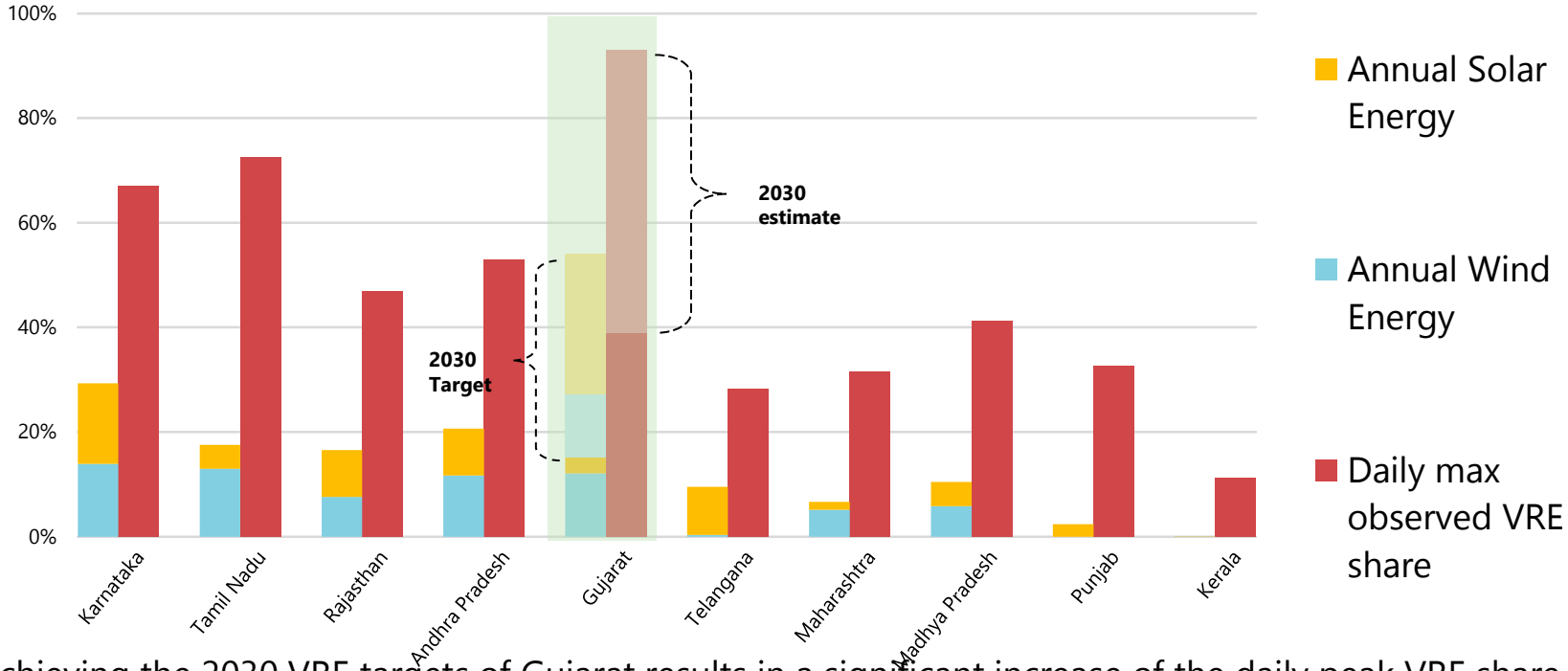


Globally most regions remain in phases 1 or 2. India's rapid energy transition already places some states in phases 2 or 3, while global examples of regions in phases 3 and 4 demonstrate a diversity of measures that can accelerate VRE integration.

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India VRE rich states comparison – Gujarat in Phase 4 in 2030

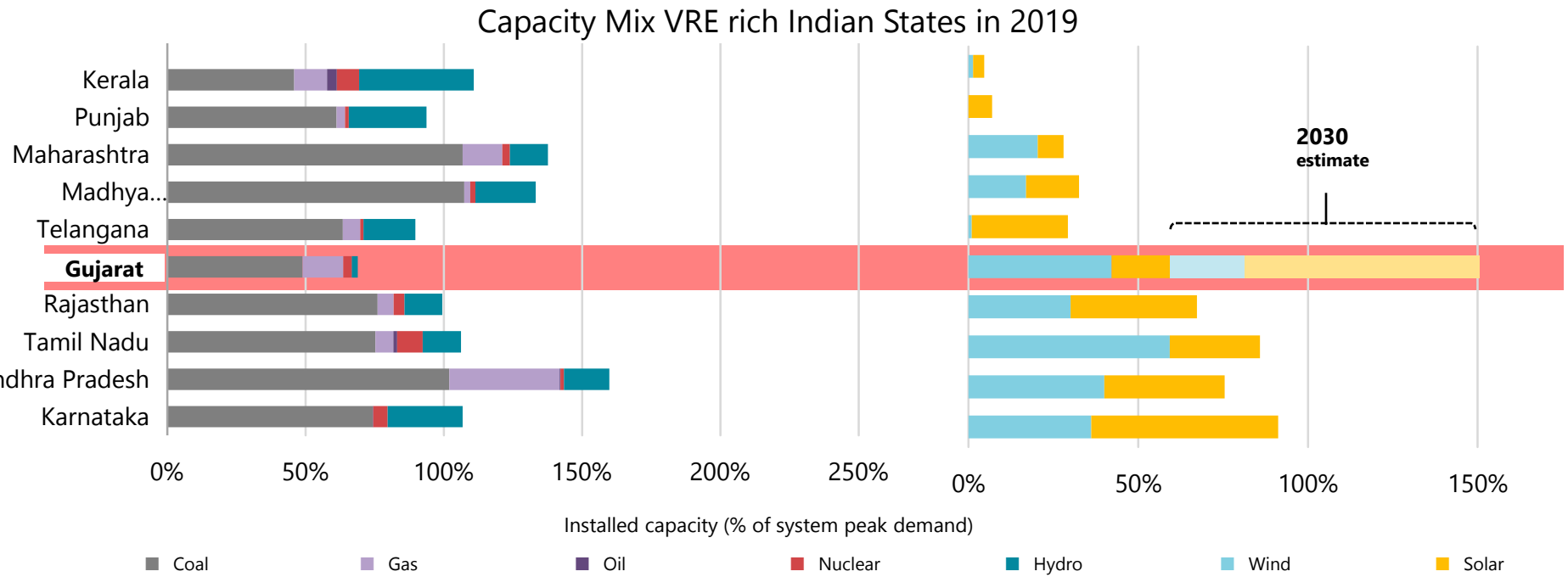
Electricity generation from VRE as a percentage of all generation in VRE-rich Indian states, 2019/20



Achieving the 2030 VRE targets of Gujarat results in a significant increase of the daily peak VRE share, placing the state in phase 4.

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Installed components of power systems relative to peak demand

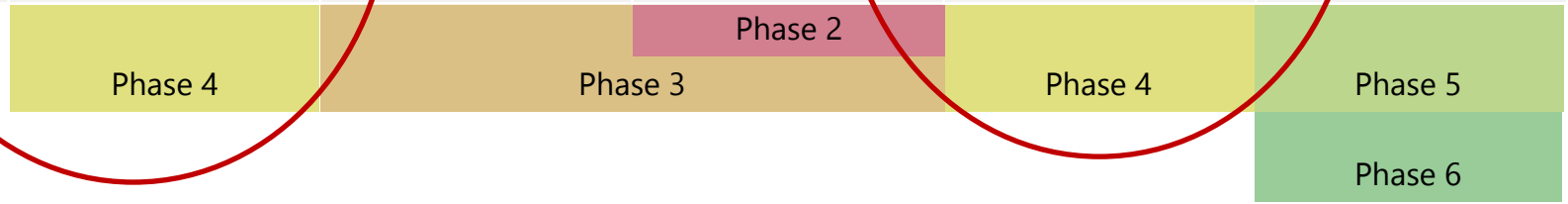


By 2030 the capacity mix of Gujarat will change completely, with substantial increase of solar and wind

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The system's flexibility needs are growing and changing

Flexibility type	Ultra short term flexibility	Very short term flexibility	Short term flexibility	Medium-term flexibility	Long-term flexibility
Timescale	Subseconds to seconds	Seconds to minutes	Minutes to days	Days to weeks	Months to years
Issue	Ensure system stability (voltage, transient and frequency stability) at high shares of non-synchronous generation	Short-term frequency control at high shares of variable generation	Meeting more frequent, rapid and less predictable changes on the supply/demand balance	Addressing longer periods of surplus or deficit of variable generation	Balancing seasonal and inter-annual availability of variable generation



Understanding the type of flexibility challenges to be expected also gives policy makers an idea of how to go about changing the policy land-scape proactively

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Flexibility solutions embedded in today's policy framework

Policy and market framework

Level of VRE penetration

System-friendly VRE deployment

- Distributed resources integration
- System services
- Generation time profile
- Technology mix
- Location
- Integrated planning

Flexible resources
planning & investments


Grids


Generation


Storage



Demand shaping

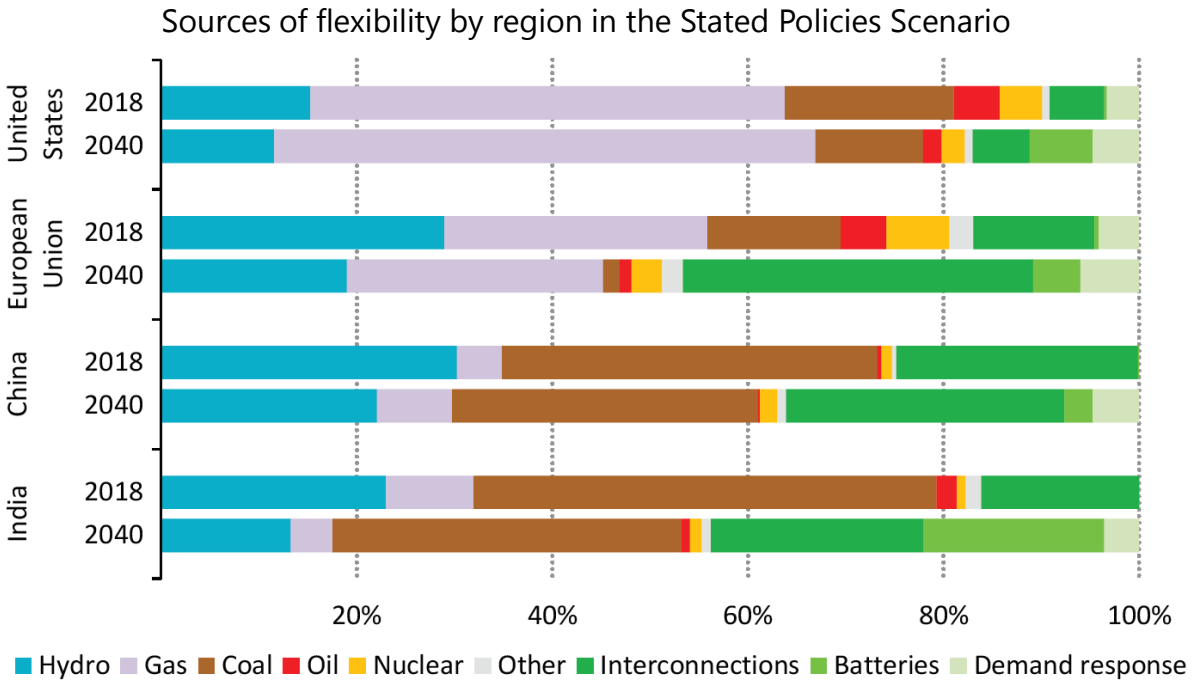
System operation and market rules

Actions targeting VRE

Actions targeting overall system

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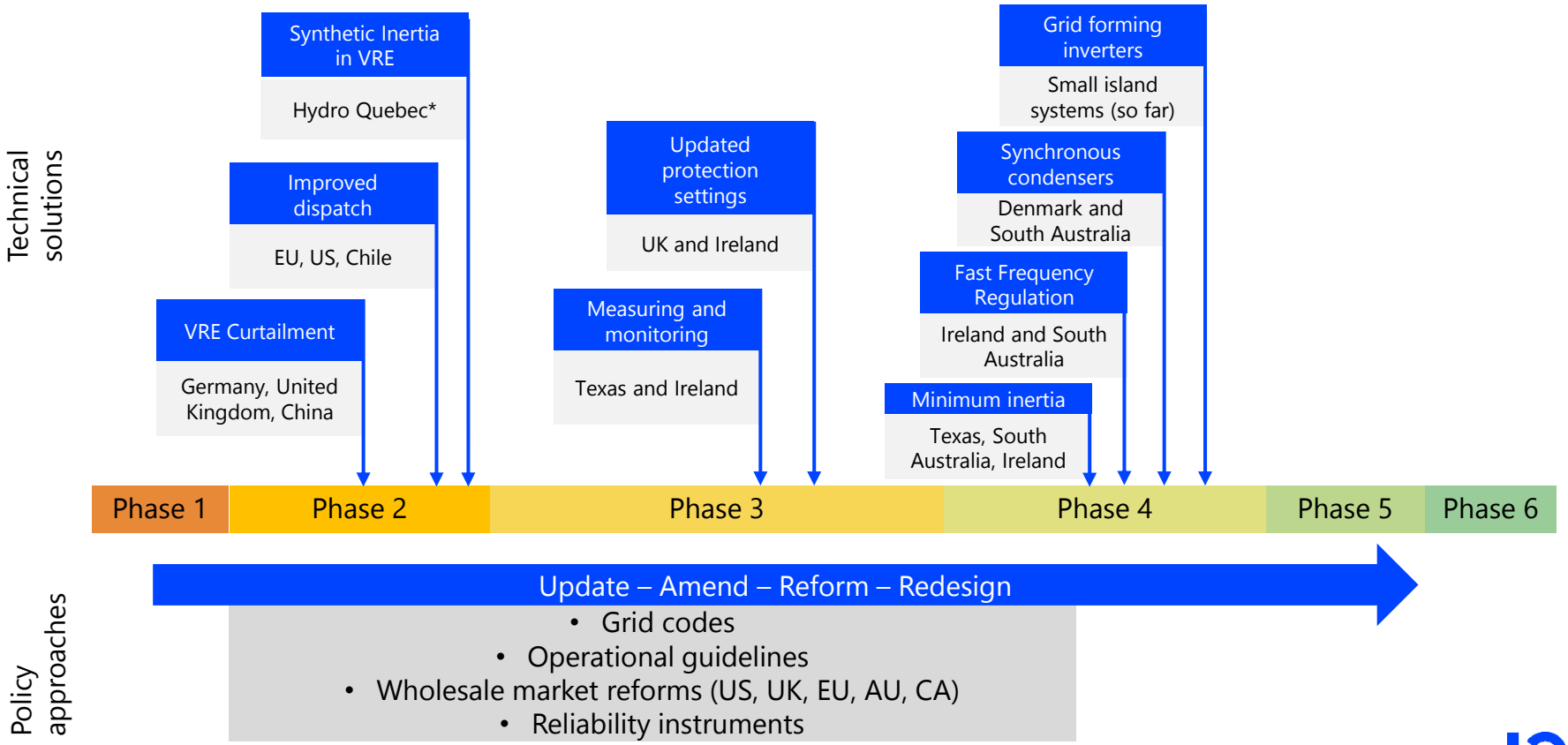
A range of Flexibility resources will be required



Thermal power plants continue to provide the bulk of flexibility needs, along with Interconnections and hydro, but storage including batteries and demand-side response are set to rise fast

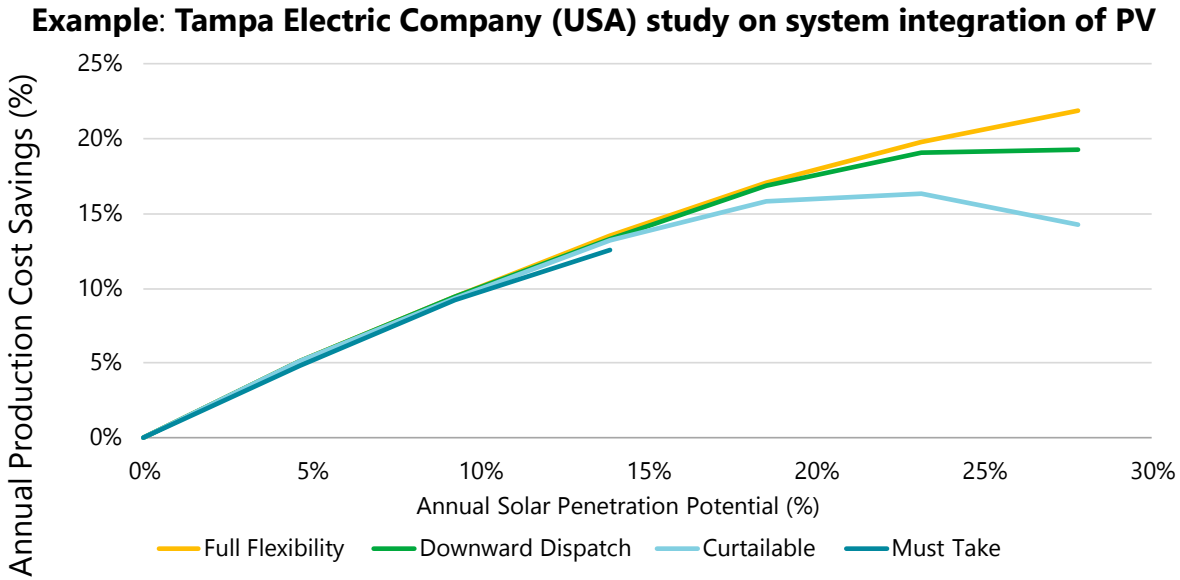
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International insights into VRE integration solutions



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US, UK, Spain, Ireland and Australia activated flexibility from VRE

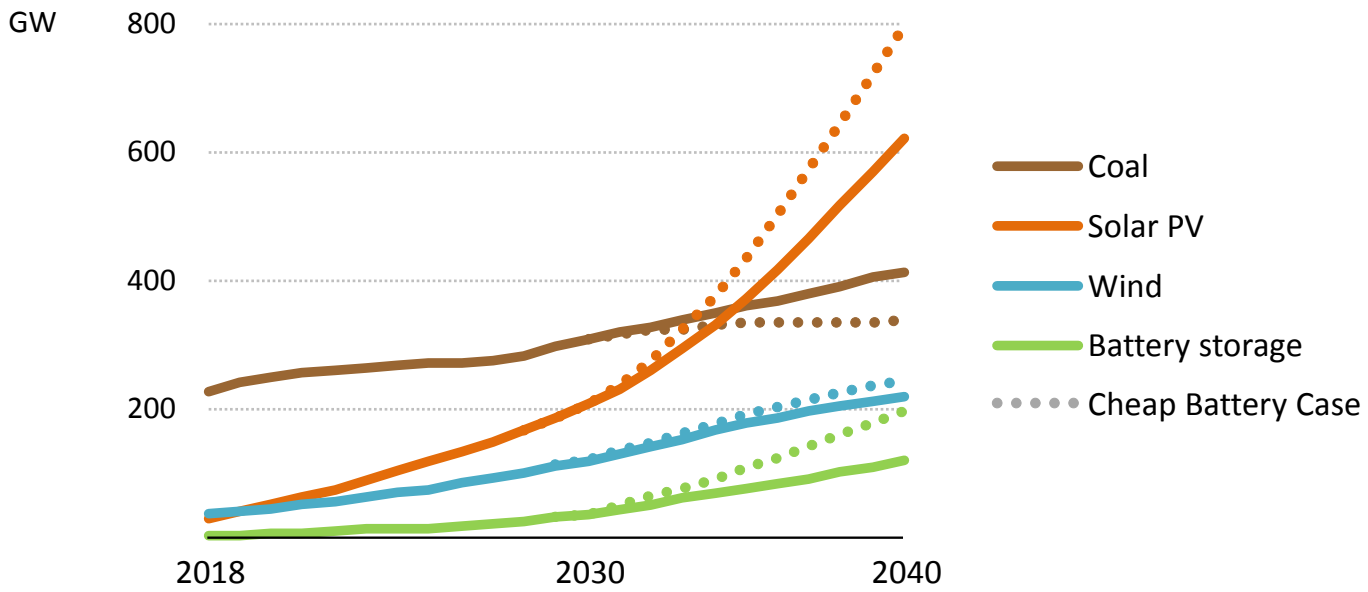


Redefining grid codes, ancillary service prequalification requirements and remuneration schemes are needed to tap into the flexibility potential from VRE. This strongly depends on the institutional framework.

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India could be the launch pad for battery storage

Installed capacity by source in India in the Stated Policies Scenario and Cheap Battery Case



Cheap batteries could enable more solar PV and wind installations in India and reduce coal use in the power sector

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International review: Revenue Streams for New Storage technologies

- **Today in most countries still significant barriers exist** for new storage technologies: **batteries, Evs, flywheels, compressed air storage, hydrogen** etc to access multiple revenue streams including **energy, capacity and ancillary services** revenues.

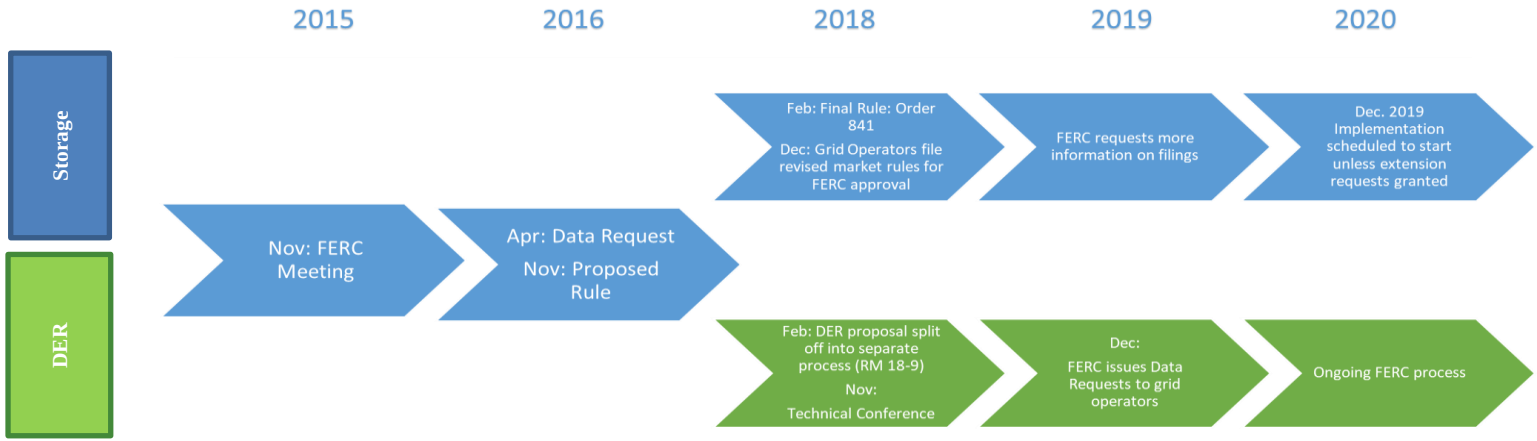
- These barriers include:
  - Storage must register as both generation and demand side resource
  - Minimum size requirements tailored to conventional generation resources and not to small new technologies
  - Duration requirements: such as 10-hours can rule our battery storage technologies (PJM)
  - Tension between jurisdictions of regulators (federal vs state)
  - Inconsistency in participation if connected to transmission or distribution level or behind the meter

- **Wholesale price signals** can show where and when the power system needs more flexibility, but they cannot deliver optimal outcomes if **market access** to new technologies and new competitors **is limited**.

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US regulatory innovation uniquely opens all markets for all technologies

- All wholesale markets: energy, capacity and ancillary services markets under 1 review process
- All storage technologies: pumped hydro, battery, flywheel and compressed air etc
- connected at all power sector levels: transmission, distribution and behind the meter
- & other FERC rules covers other flexibility resources including DER and DR and VRE
- Removing barriers to entry is the first step and it is a lengthy process, more than 5 years
- State level changes run in parallel with this national level reform



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International focus on interconnections in long term grid planning

EU grid

- Total capacity between zones is planned to increase 60% to 75% depending in the scenario compared to today
- In these scenarios for 2040, about 65 to 81% comes from RE
- Grid itself reduces marginal cost by 3 to 14 Euro/MWh in 2040 (compared to a scenario without grid expansion)

China

- Total capacity between zones is planned to increase by 500% by 2030.

Australia

- Total capacity between zones is planned to increase 50% to 70% by 2040.

Trade based on the existing intra-state and cross-border interconnectors can reduce the overall operational costs, expanding interconnectors can further reduce operational costs.

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Today's experts cover the following additional flexibility resources

Session 2

• GETCO	Transmission
• SLDC	System Operation
• ARUP	VRE operation
• GERMI	Tariff trends

Session 3

• GSECL	Coal, gas and hydro
• Ampacimon	Smart grids
• World Bank	Battery storage
• PGVCL	Demand side
• ISGF	TOU tariffs and storage
• GIZ	Rooftop solar – distributed generation

Prioritisation of these flexibility solutions including both technical approaches and policy based approaches is a complex task facing high VRE areas internationally.

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