Repowering of Old Wind Turbines in Southern Region in India

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Presentation Outline

- Background for Repowering Study
- Repowering Potential Assessment
- Stakeholder Consultation for identifying Key Challenges
- Proposed Business Model and Incentive computation
- Repowering Policies
- Way forward

Background

- Development of wind power projects in India started way back in mid-1990's.
- These wind power projects are located at the wind resource rich sites and having low capacity of sub-500 kW range with hub height of 25-30 m.
- As per research, such projects have an average CUF of only 10% to 14% even though these sites have very good wind resource.
- If such sites replaced with modern day turbines one could easily derive 30% CUF & upwards.
- Also, in addition to greenfield wind projects, such brown field capacity addition can contribute significantly to achieving wind capacity addition targets

Objectives : Repowering Study by IGEF

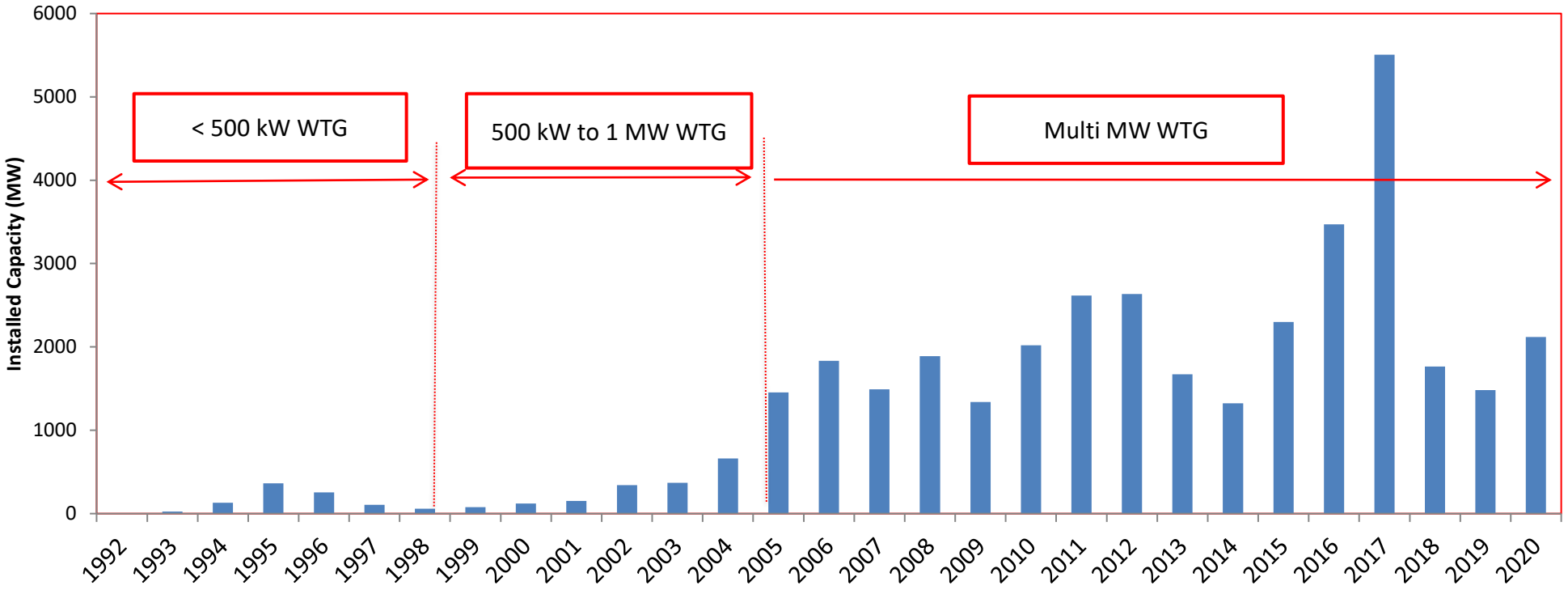
- **Indo-German Energy Forum (IGEF) – Support Office** has initiated study to evolve framework to promote the concept of Re-powering of wind turbines.
- In this context, the IGEF Support Office has engaged **M/s Idam Infrastructure Advisory Pvt Ltd (Idam Infra)** to carry out the study and engage with key stakeholders in the wind industry.
- The study was supported by MNRE and NIWE.

Objectives

- ❑ To understand Repowering market developments: Global & Indian
- ❑ To analyze major factors influencing decisions of repowering investments
- ❑ To evaluate financing requirements for repowering project(s)
- ❑ To evolve policy and regulatory measures needed to pursue repowering in India
- ❑ To estimate total market potential and assess business opportunity for repowering in India

Wind power development in India

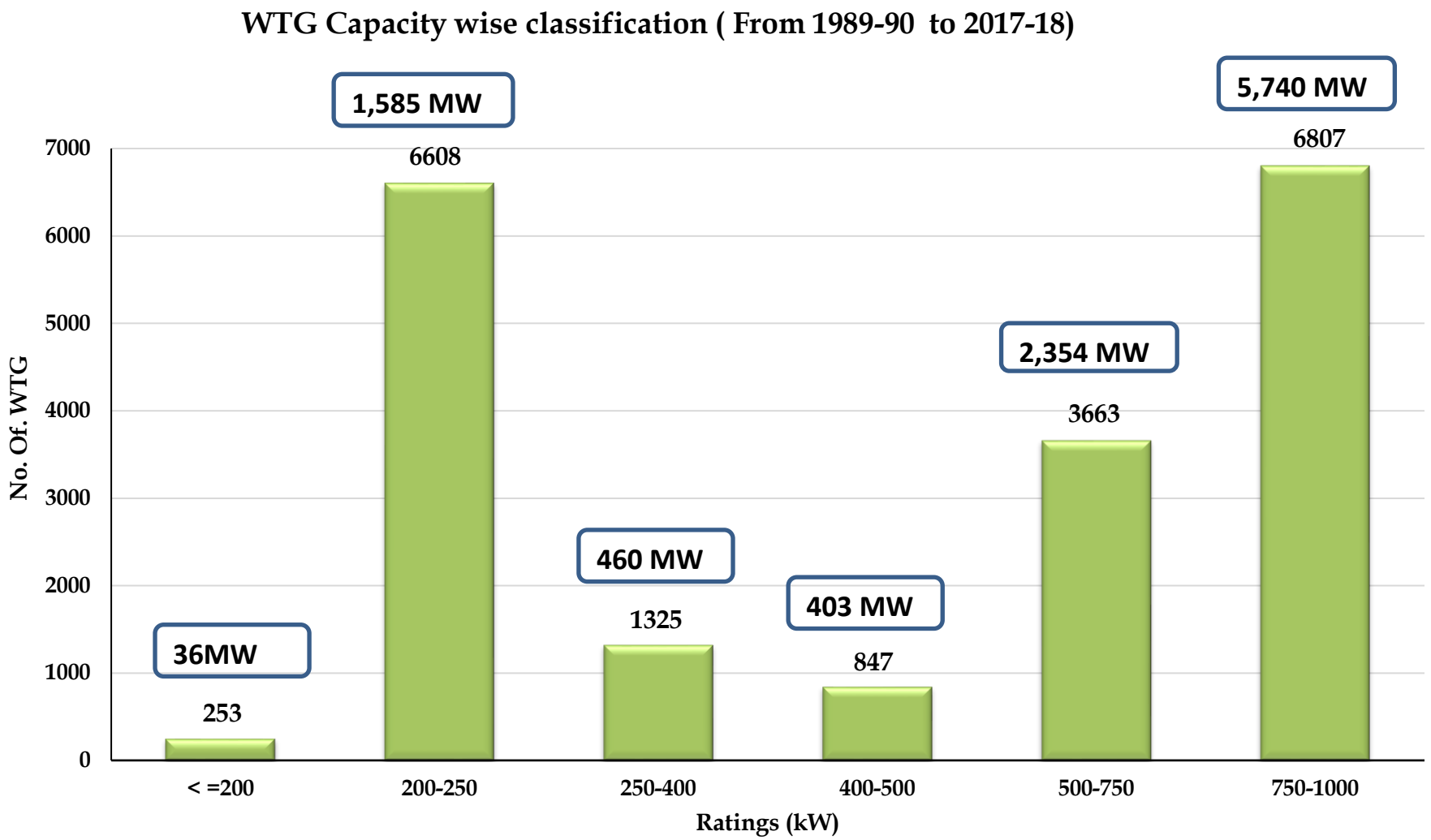
India has **fourth** largest wind energy installations in the world, with installed capacity of **38,789MW** (as on Feb 2021).



- Around ~ 10% of installed capacity comprise WTGs with Unit Size less than 500 kW.
- Most of these projects are located at sites with WPD > 250 W/m2 at 50 m.

Classification of installed WTGs (< 1 MW) by turbine capacity size

There are ~19,500 WTGs with installed capacity of <1 MW.



Need & benefits of Repowering

- More wind power from the same area of land:
  - wind power generation is multiplied without the need for utilizing additional land;
- Fewer wind turbines:
  - the number of turbines can be reduced while enhancing the natural landscape. The construction height can be raised;
- Higher efficiency, lower costs:
  - modern turbines make better use of available wind energy. The cost of production is significantly lowered;
- Better power grid integration:
  - modern turbines offer much better grid integration, since they use a connection method similar to conventional power plants and also achieve a higher utilization degree;
- Better appearance:
  - modern turbines rotate at much lower speeds and are thus more visually pleasing than older, faster-rotating turbines;

Repowering Potential Assessment

- Results for Re-powering potential assessment

  - ❑ WTGs with operational life of 15 years (commissioned prior to 2002).
  - ❑ Unit size of each WTG (< 1000 KW).
  - ❑ *Quantified figures for potential of major wind rich states are given in the subsequent slides*

- Research methodology – database/sources

  - ❑ Potential assessment analysis done for all India basis
  - ❑ Potential assessment of few sites in TN & GJ
  - ❑ Analysis of the wind directory 2017 as published by CECL.
  - ❑ Scenario analysis for projects commissioned prior to 2002 and WTG capacity size

Repowering Potential Assessment (As on 2017)

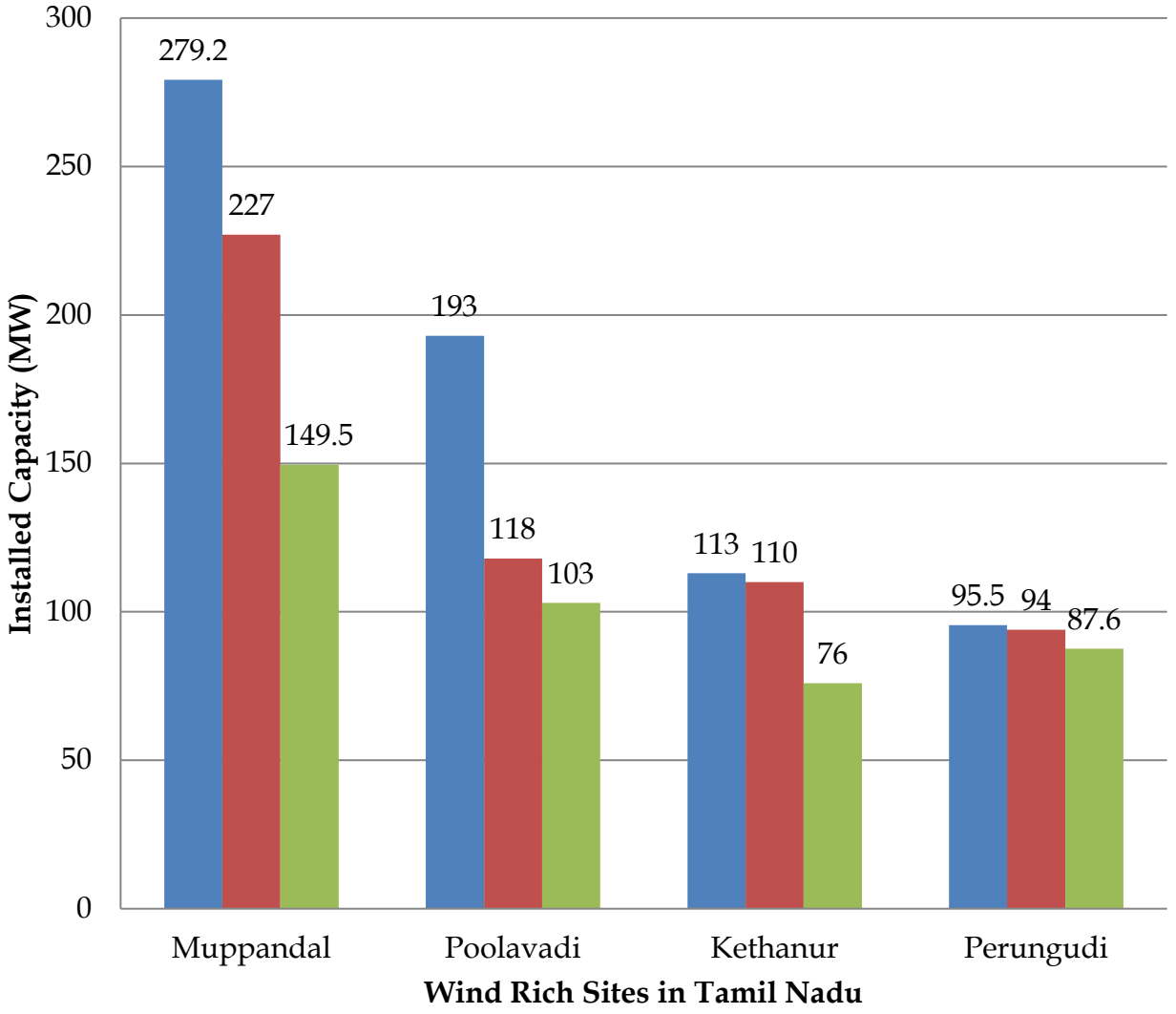
State wise Break-up of All India installed WTGs (COD prior to 31-Mar-2002)

Break-up of All India installed WTGs (COD prior to 31-Mar-2002) (Fig in column (2) & (3) in kW and in column (4) in MW)			
State	**<=500 kW**	**501 to 1000 kW**	**Total (MW)**
Andhra Pradesh	84,890	1,500	**86**
Gujarat	1,51,795	2,200	**154**
Karnataka	30,075	36,900	**67**
Maharashtra	2,41,795	1,59,150	**401**
Madhya Pradesh	21,100	0	**21**
Rajasthan	14,040	0	**14**
Tamil Nadu	7,75,780	58,250	**834**
Kerala	225	0	**0.23**
Total	**1319,475**	**258,000**	**1577**

(Source : India Wind Power Directory 2017)

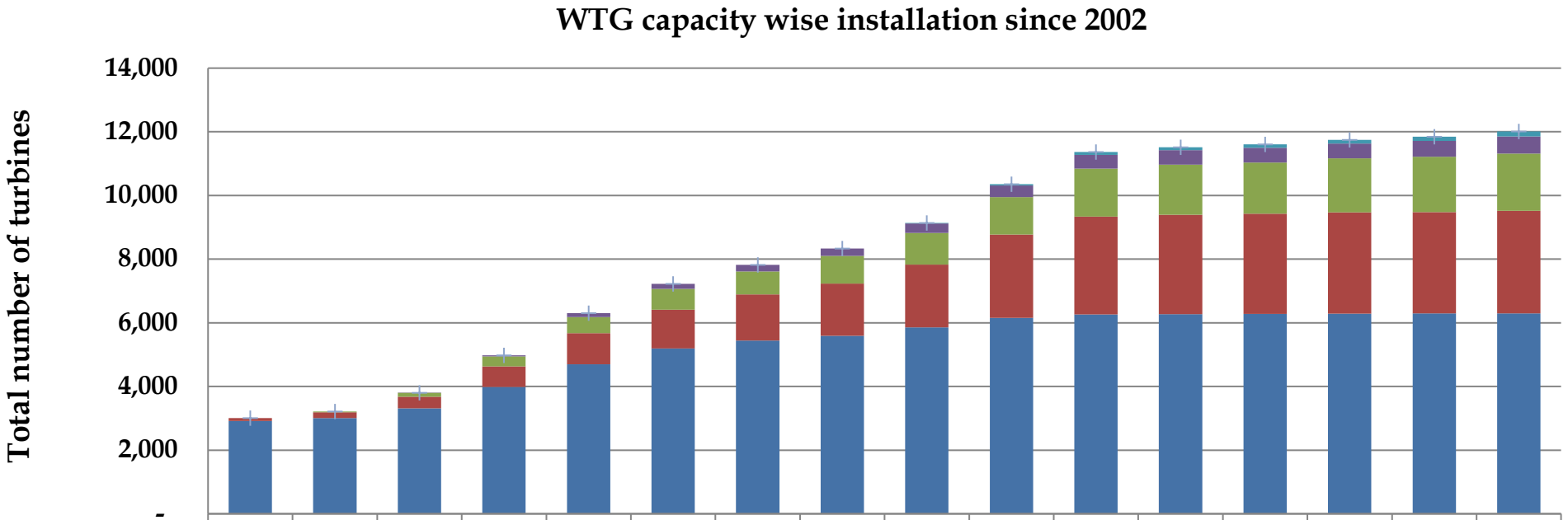
- Est. Repowering Potential for WTGs with size **(<=1000 KW & COD prior 2002)**, is **1,577 MW.**
- **Tamil Nadu, Maharashtra and Gujarat** lead the repowering business opportunity.

Tamil Nadu : Analysis of Sites with high Repowering Potential



- As part of the study, 4 sites were looked at, which were old as well as considered best sites
- These 4 sites put together has immediate repowering potential of ~415 MW (<500 kW & before 2002 installation)

Tamil Nadu : WTG capacity-wise Annual installations



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
> 2000	-	-	-	-	-	-	-	-	15	43	94	96	107	117	134	157
>1500 and <= 2000	-	-	3	32	118	165	206	237	296	363	423	448	462	470	497	540
> 1000 and <= 1500	-	30	124	309	508	648	725	865	1,000	1,176	1,512	1,579	1,607	1,694	1,734	1,795
> 500 and <=1000	91	179	366	650	973	1,221	1,447	1,643	1,969	2,616	3,071	3,118	3,150	3,177	3,187	3,224
<=500	2,913	3,008	3,310	3,983	4,700	5,192	5,442	5,588	5,854	6,157	6,262	6,272	6,276	6,289	6,291	6,296
Total no of turbines	3,004	3,217	3,803	4,974	6,299	7,226	7,820	8,333	9,134	10,355	11,362	11,513	11,602	11,747	11,843	12,012

- By the end of 2017, there are still 6,296 turbines in Tamil Nadu having capacity sizes less than 500 kW of WTG size

Repowering Potential Assessment 10 years down the line (As on 2027)

State wise Break-up of All India installed WTGs (COD prior to 31-Mar-2012)

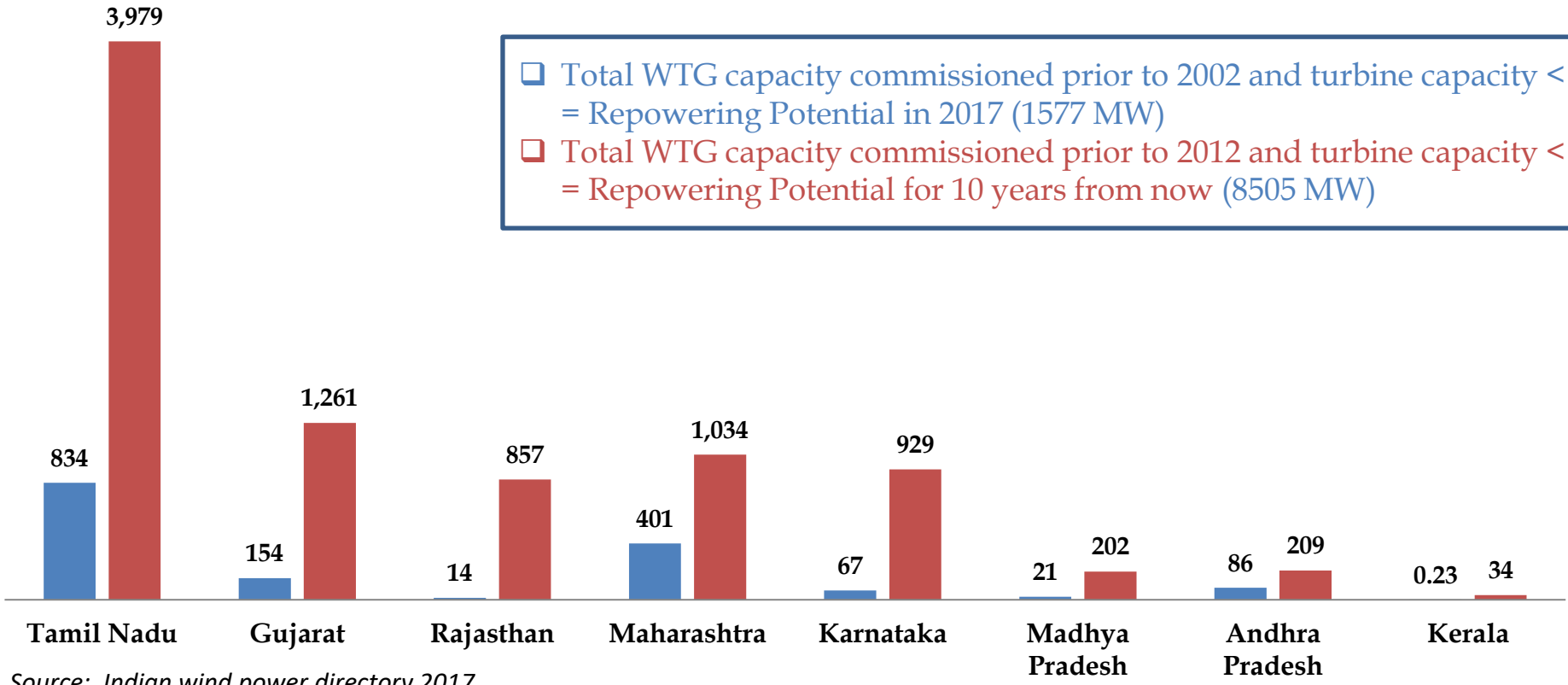
Break-up of All India installed WTGs (COD prior to 31-Mar-2012) (All fig in MW)	
State	**Total (MW)**
Andhra Pradesh	209
Gujarat	1261
Karnataka	929
Maharashtra	1034
Madhya Pradesh	202
Rajasthan	857
Tamil Nadu	3979
Kerala	34
Total	**8,505**

(Source : India Wind Power Directory 2017)

- Est. Repowering Potential for WTGs with size **(<=1000 KW & COD prior 2012)**, is **8,505 MW.**
- **Tamil Nadu, Gujarat** and **Maharashtra** lead the repowering business opportunity.

Repowering potential estimate for major wind rich states of India

Repowering potential in wind rich states



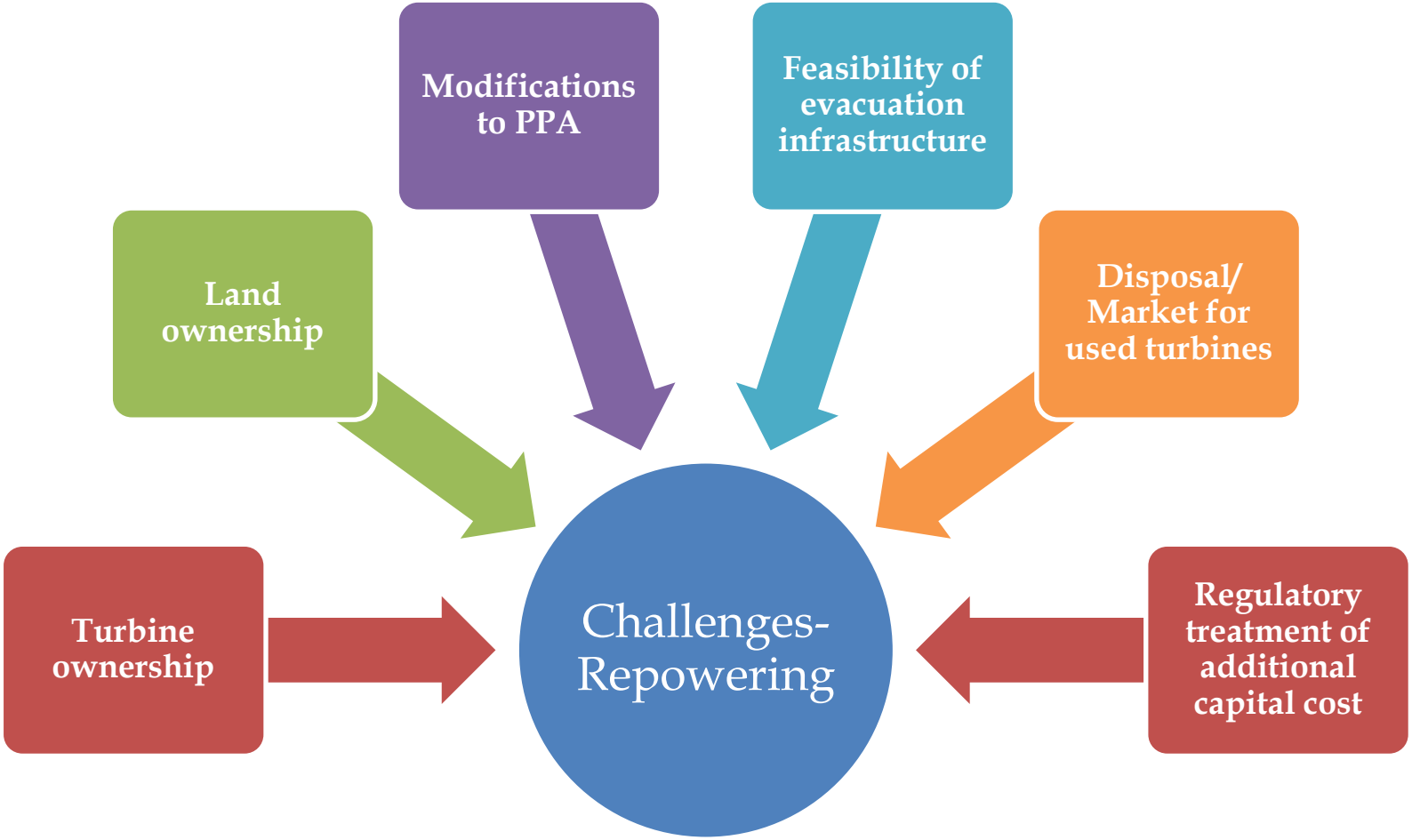
- Total WTG capacity commissioned prior to 2002 and turbine capacity < 1 MW = Repowering Potential in 2017 (1577 MW)
- Total WTG capacity commissioned prior to 2012 and turbine capacity < 1 MW = Repowering Potential for 10 years from now (8505 MW)

Source: Indian wind power directory 2017

- Potential business opportunities for repowering are plenty.
- Long term repowering program with continuity of policy & regulatory regime would be necessary

Stakeholder consultation for identifying key challenges

Identifying key challenges in Repowering



Stakeholder consultation provided useful insights into above key considerations.

Repowering study: Stakeholder consultation

- Initial consultation meetings held with agencies such as NIWE, Nodal Agencies in Gujarat & Tamil Nadu and IWPA, InWEA, IWTMA.

- **Background research** on the international experience & Indian wind repowering market potential assessment carried out.

- In order to gather **different perspective(s) of various stakeholders** associated with repowering, **a consultation process through structured interview** held.

- **Questionnaire circulated to following stakeholder groups as under:**
  - SNA (5): GEDA, KREDL, MEDA, TEDA, RRECL
  - State utilities (14) : Gujarat, Maharashtra, Karnataka, Rajasthan, Tamil Nadu, Tata Power
  - SERCs (6): GERC, MERC, KERC, MPERC, RERC, TNERC
  - Wind Industry associations : IWPA, InWEA, IWTMA, WIPPA.
  - Wind developers/IPPs (15)
  - WTG manufacturers (5)

Main challenges for repowering and suggestions for framework..1/2

Issue	Key Challenges by Respondents	Suggestions
Ownership	• Ownership of windfarm with multiple wind turbine owners in given wind farm is an issue. • **All parties/WTG owners may not be willing** to opt for repowering.	• A suitable business model has to be evolved where interest of all parties are taken care of. • **Formation of SPV with equity participation** from concerned parties with sharing of revenue in proportion to equity interest could be a solution.
Evacuation	• **Most of the old wind projects are connected to 11 KV line** *(particularly in TN)*, which poses as the major hurdle for any repowering initiative.	• **The evacuation infrastructure has to be upgraded** to 66 KV. • In some cases, up-gradation of the pooling s/s may be required as well.
Land	• Multiple ownership of land for a given wind farm poses another challenge for repowering project. • **Optimal micro-siting for repowered site require** unhindered access & planning flexibility to land site.	• **Lease of land or right to use land on footprint basis in favor of SPV** could be explored to address requirement in case of multiple land owners.

Main challenges for repowering and suggestions for framework..2/2

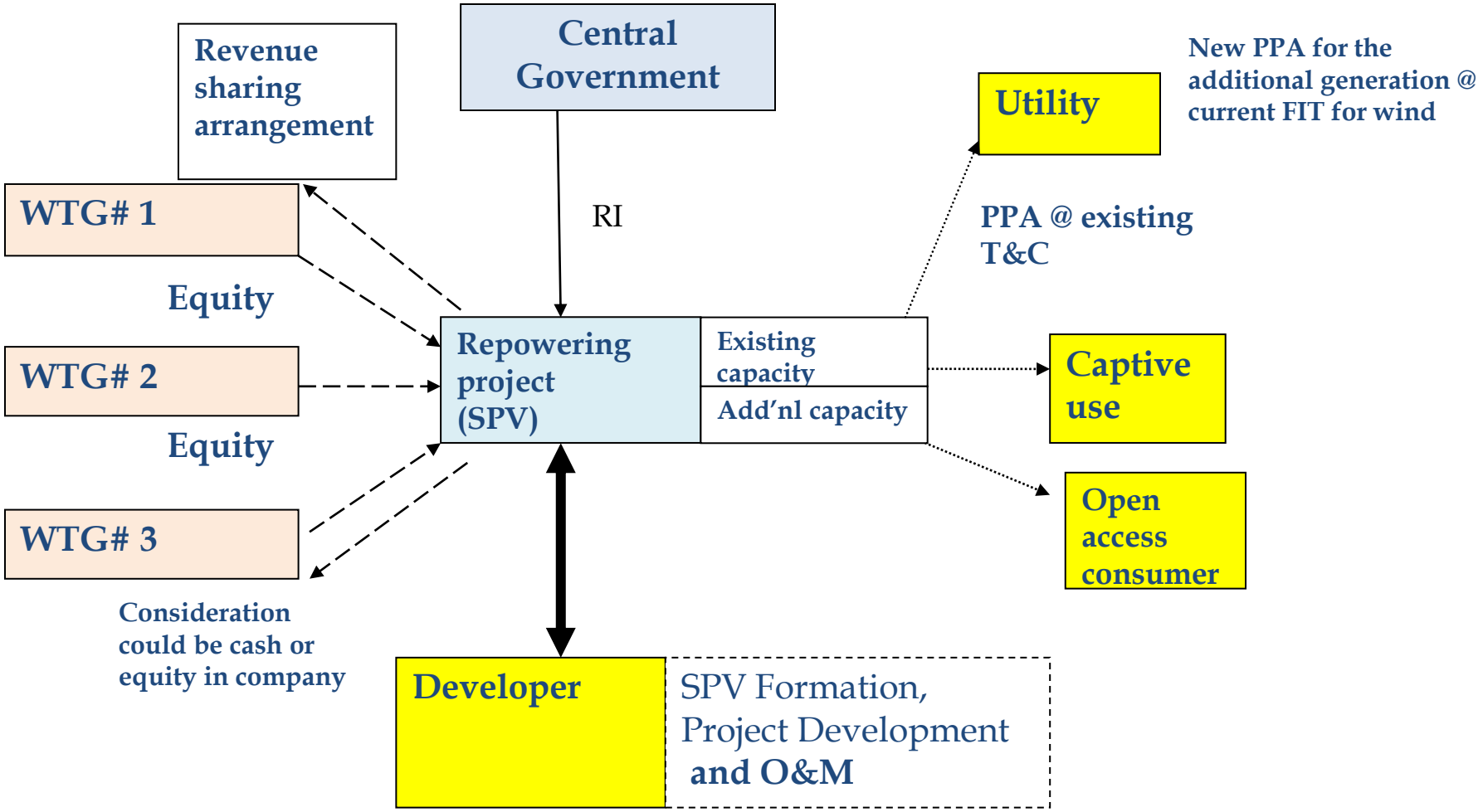
Issue	Key Challenges by Respondents	Suggestions
Off-take arrangement	• **Retaining earlier off-take arrangements** (sale to DISCOM or captive) and identifying off-takers for excess generation	• There exist multiple options for offtake. Viz. a) Sale to Discom. b) Captive model. C) Sale to any 3rd Party by open access route and combination to be allowed. • **Existing off-take to be protected at least for residual life period.**
Tariff & incentives	• Existing tariff is too low as the PPAs are over 20 years **with perpetual nature with no termination clause.** • Tariff is unviable for repowering projects.	• For repowered capacity, **a certain incentive over and above the FIT** would be required for the developer. • In case of **captives, attractive wheeling and banking provision** needs to be brought in.
Utility	• Utility is in a secured PPA with developer at a much lower tariff. • **It would not allow prior termination of PPAs to enable repowering.**	• **Utility off-take as per old PPA rates to continue for balance tenure of existing PPA.** • New PPA shall cover the new FIT for additional generation through repowering.

Proposed Business Model
and
Principles for Incentive

Desired features of proposed business model

- As fragmented ownership of wind farm is an issue, a SPV can be formed with equity contribution from each interested party, with agreement to share revenue in proportion to equity contribution.
- SPV would procure the existing assets, both turbines and required land use rights.
- Interest of the utility in terms of existing PPA (at least for balance tenure of PPA) has to be protected.
- Consumers would benefit from proposed repowered scheme in terms of enhanced renewable generation from given wind farm site.
- The model has to be supported by the Government in terms of incentives to make it financially viable for developer.

Proposed SPV-Business Model for Repowering



Principles for determination of Incentive

- **Incentive requirement would vary from state to state and depending on type of off take arrangement.**

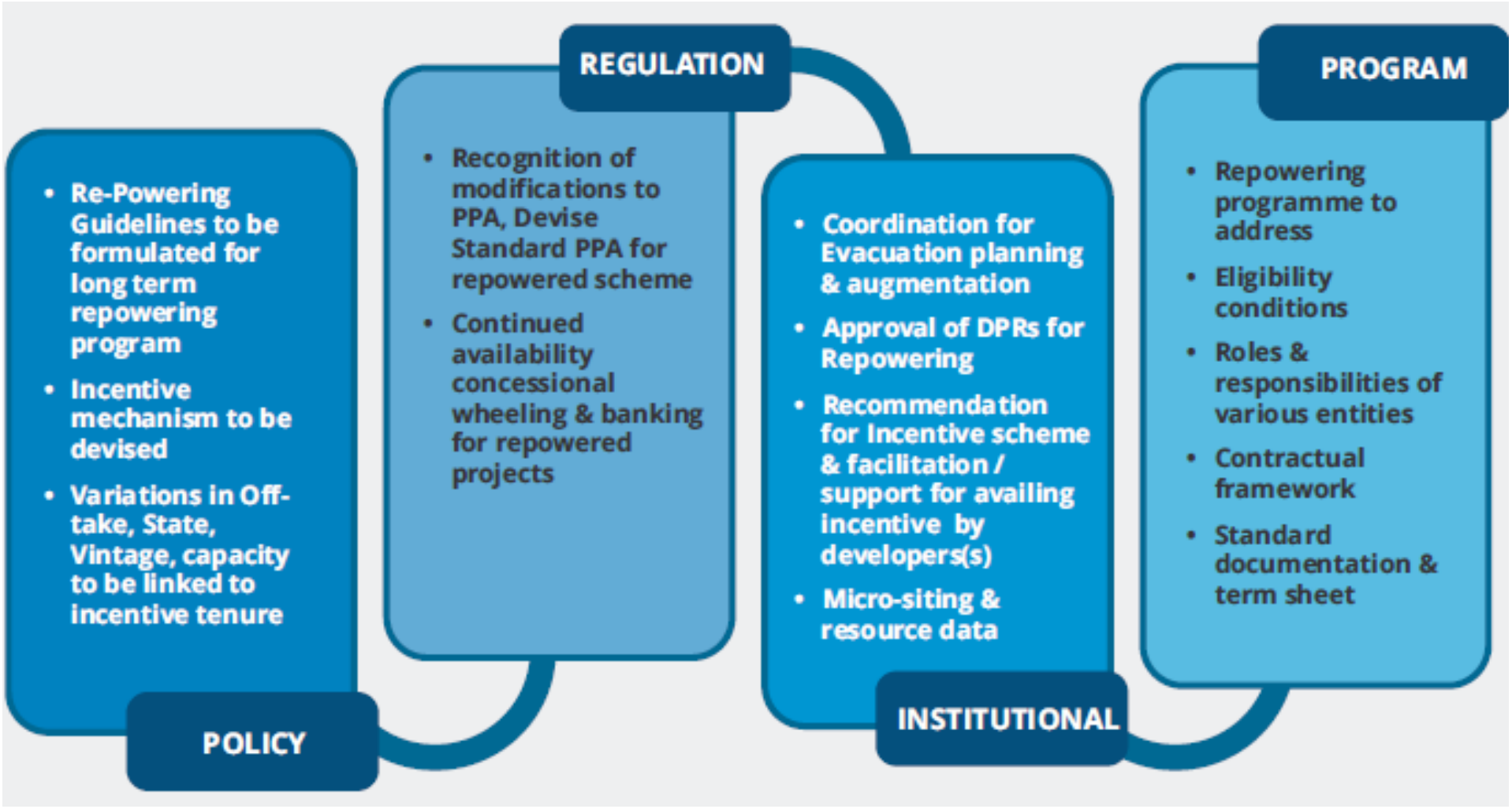
- **Incentive is required to address following:**
  - Cost of equivalent generation to serve Utility as per existing PPA rate at least for balance PPA tenure
  - Loss of revenue during transition period during repowering
  - Acquisition cost of existing assets, costs associated with SPV formation
  - Decommissioning costs associated with old wind project

- **However, in following cases, the cost implications would be minimal.**
  - For Captive / Group captive / Single Owner arrangement(s), there may not be requirement to form SPV or acquiring existing asset(s) / land transfer.

Key findings for Incentive requirement

- Incentive requirement **varies from State to State** depending upon the prevalent tariff regime.
- The **nature of off-take arrangement**, viz. Sale of Utility, Captive wheeling or Third party wheeling also greatly influence the need for incentive requirement within a state.
- **Continuation of the concessional banking & wheeling arrangements and cross-subsidy surcharge** plays important role in assessing the incentive requirement and viability of the repowering project.
- For a repowering project, apart from energy yield, cost economics and incentive framework, **it is possible to devise multiple project scheme with various offtake arrangements.**
- **Structuring of the Repowering Project, would play important role in devising repowering project scheme.**

Key interventions required



Repowering Policies

- Policy for Repowering of Wind Power Projects-2016 by MNRE
- Gujarat Repowering of the wind projects-2018
- Andhra Pradesh Wind Power Policy-2018
- Rajasthan Wind and Hybrid energy Policy-2019
- Procedure to be adopted by TANGEDCO for Repowering of WEGs in Tamil Nadu-2021
- Karnataka Renewable Energy Policy 2021-26 (Under Stakeholder Comments)

Repowering policies do not address core concerns such as development model, incentive requirement, mandate for re-powering and programmatic approach, supported with pilot project

Towards Repowering in India . . .

Thank You