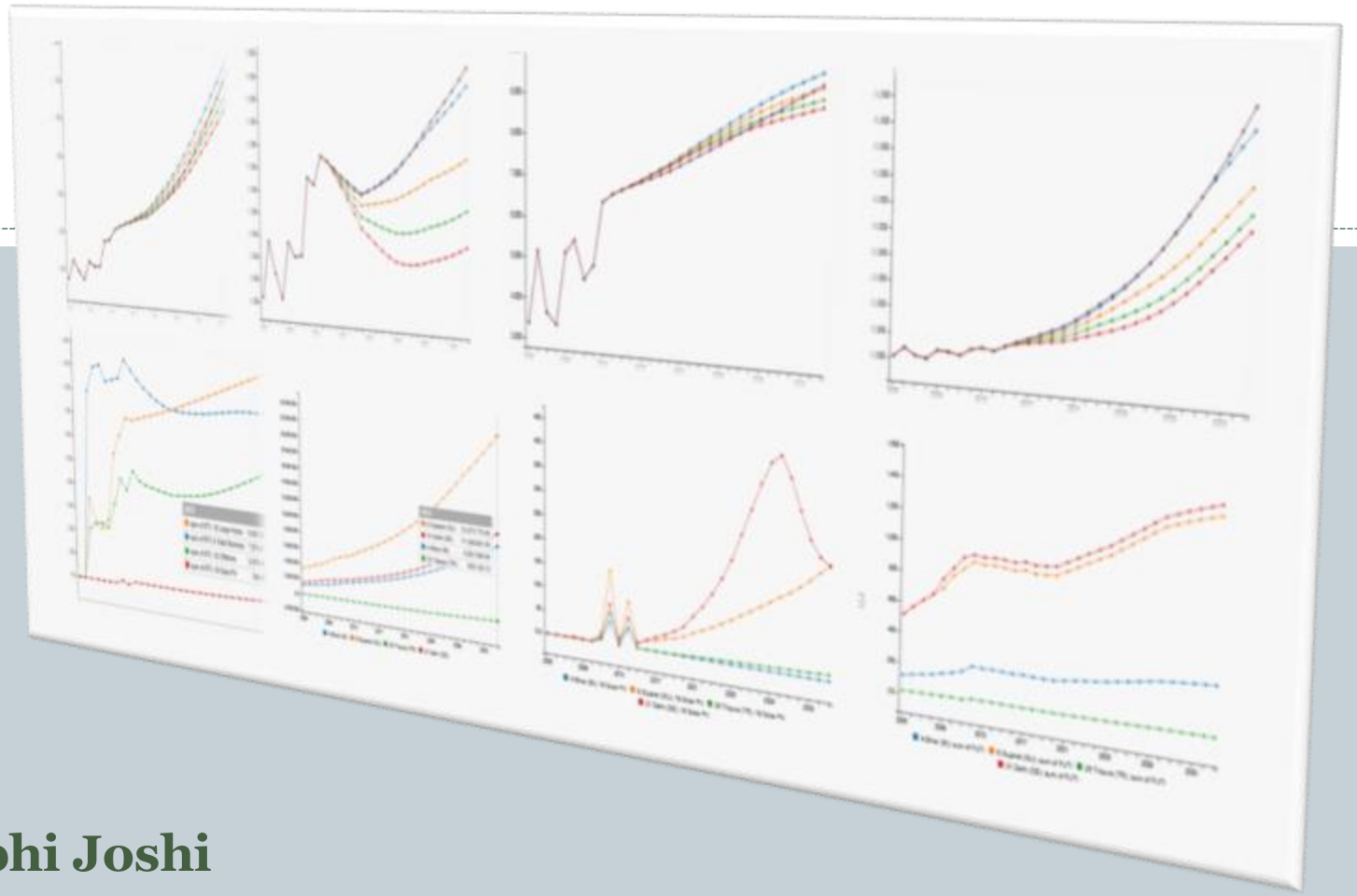
Simulations with E3 India Model

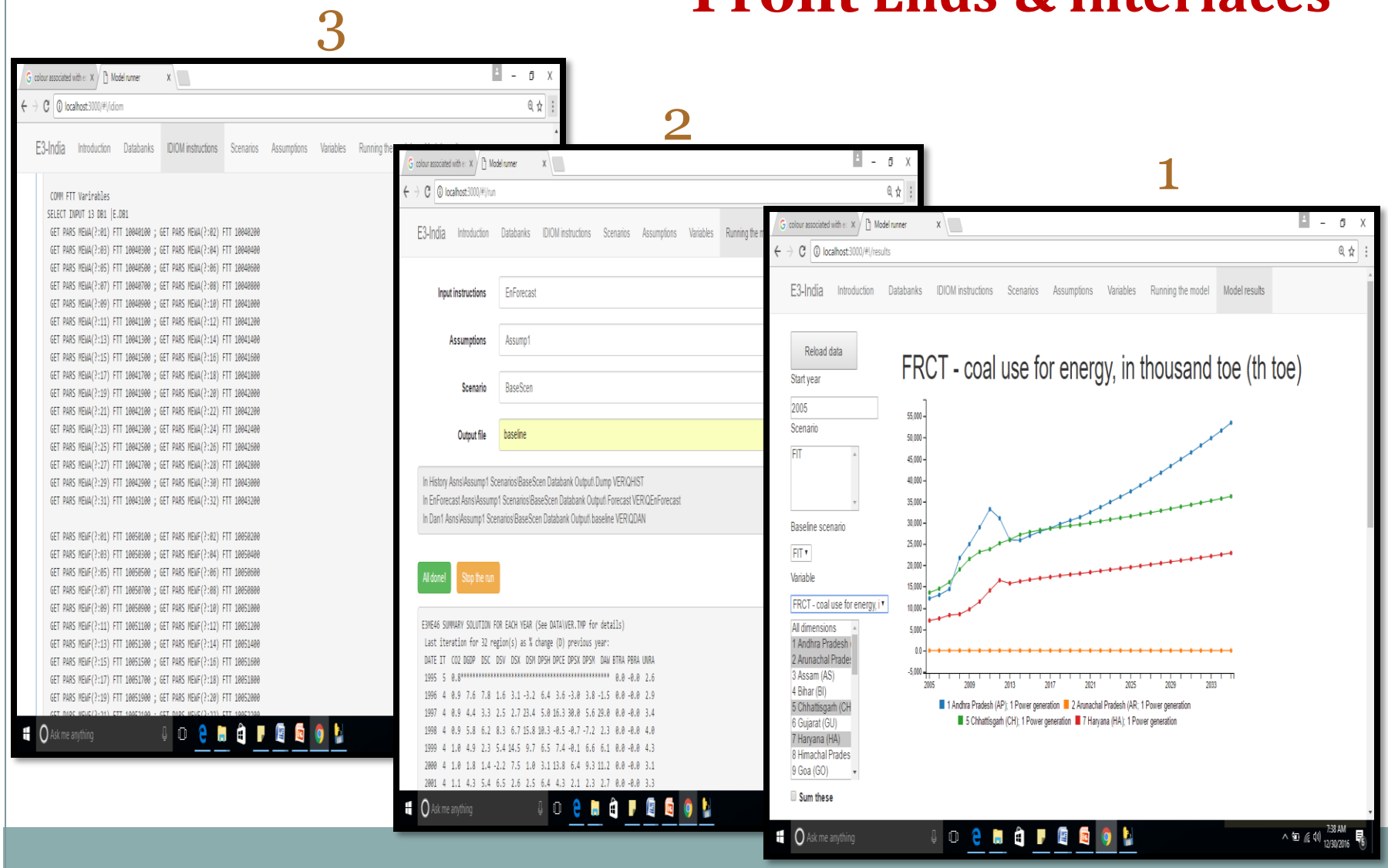


Surabhi Joshi

IORA conference, January 2017

E-3 INDIA As a Tool

Front Ends & Interfaces



E3 India Model :Tool Components

IDIOM Instructions	Scenarios	Assumptions	Variables (over 140)
Model Text File Inputs	Model Policy Inputs	Model Exogenous Assumptions	Output Variables
Editable .idiom text files			preloaded

Model Specifications

- 32 Indian states and territories
- 20 economic sectors
- 8 users of 5 different energy carriers
- 10 types of atmospheric emission
- annual projections out to 2035
- Over 140 listed output variables

Scenario Analysis

Boundaries & Contexts

Context of Renewable Energy Technology (RET) Transitions in India is explored to

- Demonstrate policy impacts at different geographic resolutions (regions) (Single-Aggregate-All)
- Assess flexibility of model with respect to technology and simulation of new policy scenarios using FTT
- Explore E3- India's unique energy, environment, and economy (the Es in "E3") framework to understand impacts of policy both within the sector and beyond

Regional Differentiation

High-RET states	Low-RET states	Remote northeastern states	Union Territories
1	2	3	4
Maharashtra	Bihar	Assam	Goa
Madhya Pradesh	Jharkhand	Tripura	Delhi
Gujarat	Uttarakhand	Meghalaya	Chandigarh
Rajasthan	Haryana	Arunachal	Pondicherry
Tamil Nadu	Odisha	Manipur	Andaman Nicobar
Karnataka	Himachal	Nagaland	
Chhattisgarh	Pradesh	Mizoram	

The growth trends for four renewable energy technologies (RET) for four regionally differentiated categories

Output Variable :**MEWG**-Electricity Generation per year (GWh/year)

RET : Solid Biomass, large Hydro, On shore Wind and solar PV

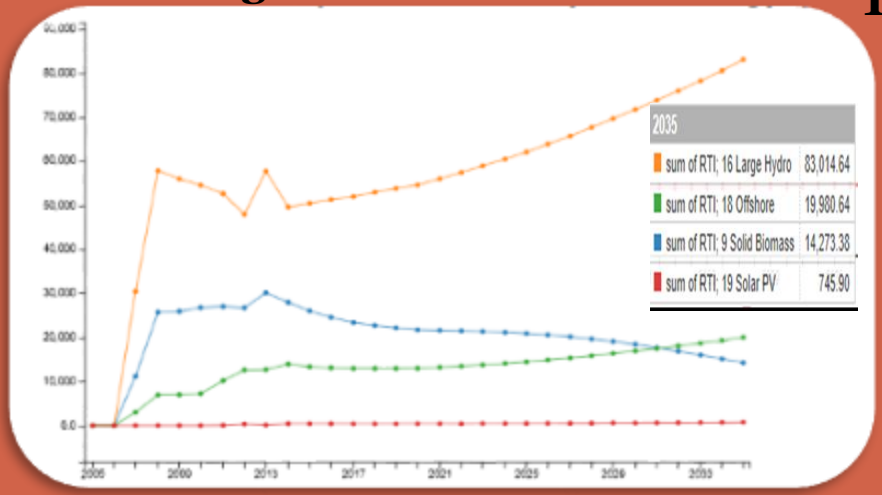
Time period : 2005-2035

Categories : 1) High RET States 2) Low RET states,
3)Remote North eastern States
4) Union Terriotories

MEWG-Electricity Generation per year (GWh/year)

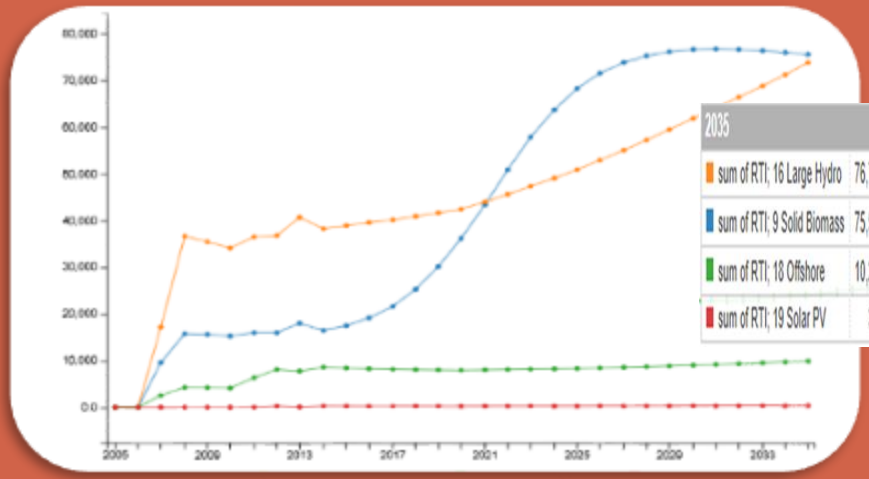
High RET States

1



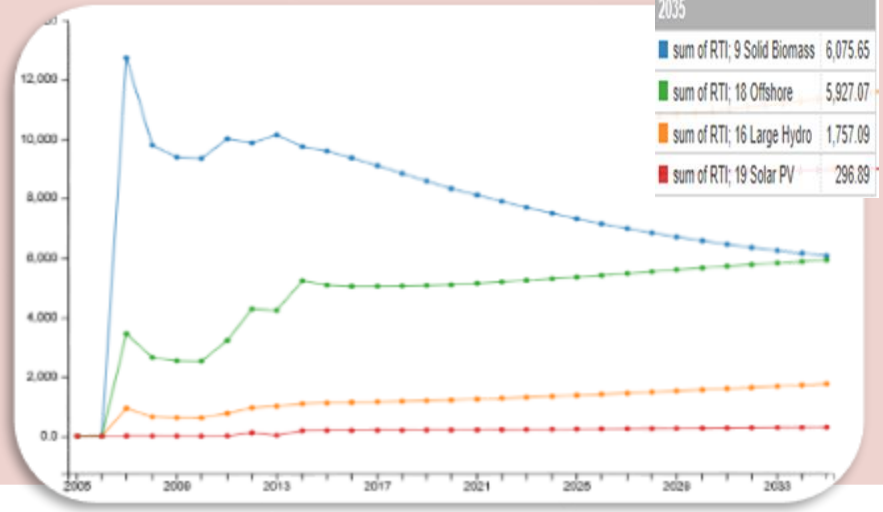
Low RET States

2



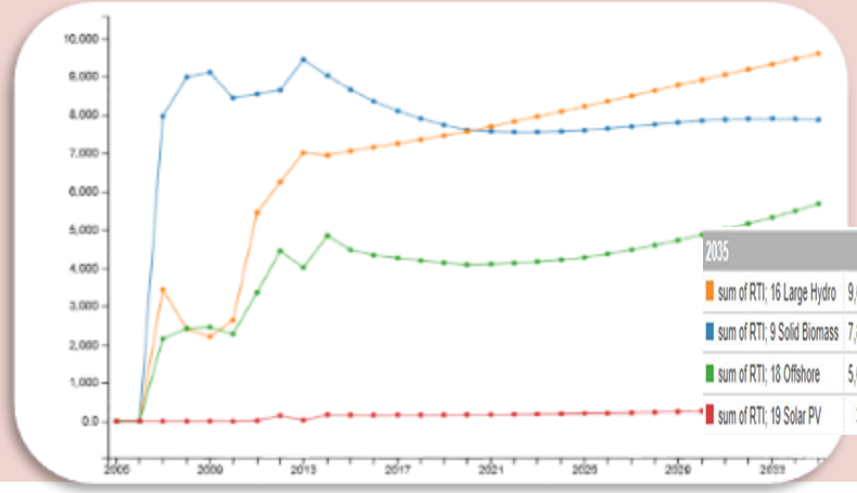
North Eastern States

3



Union Territory

4



Solid Biomass, large Hydro, On shore Wind and solar PV

- States with high RET capacity would be the forerunners in solar and wind installations when simulated till 2035

- Solid biomass and large hydro would have significant share in renewables for all the categories

- The promotion of solar PV would be more aggressive in Union Territories than in northeastern states or low-RET states

Impact Simulation
New Policy Interventions

- **How can generation based incentives (Feed in Tarrif) for renewables impact GHG emissions profiles across regions in India ?**

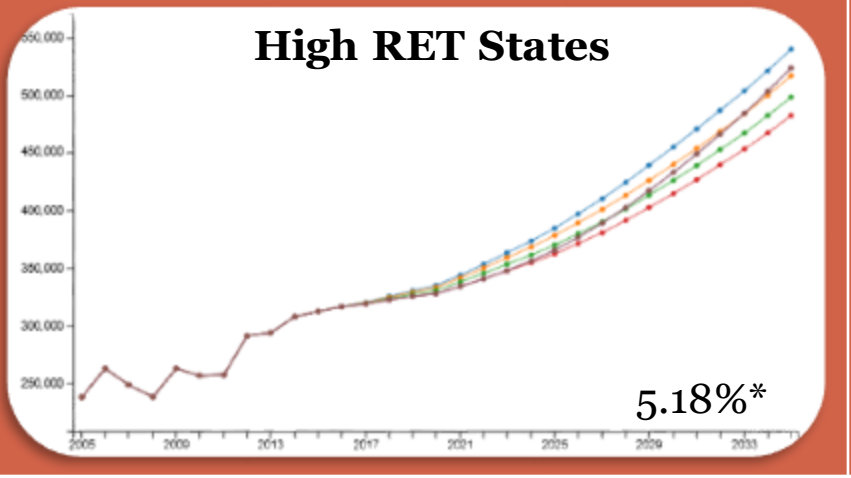
Output Variable : FCO2: User emissions of carbon dioxide, thousand tonnes carbon (thtC)

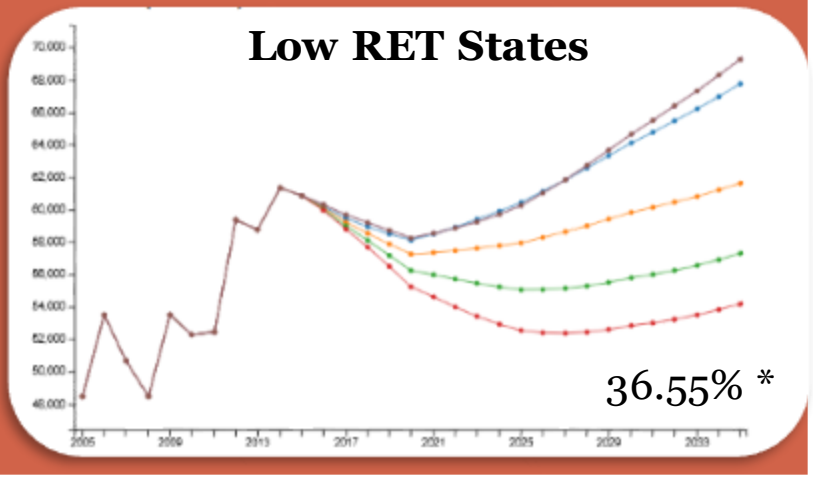
Technologies : solid Biomass, Large Hydro, On shore wind and solar PV

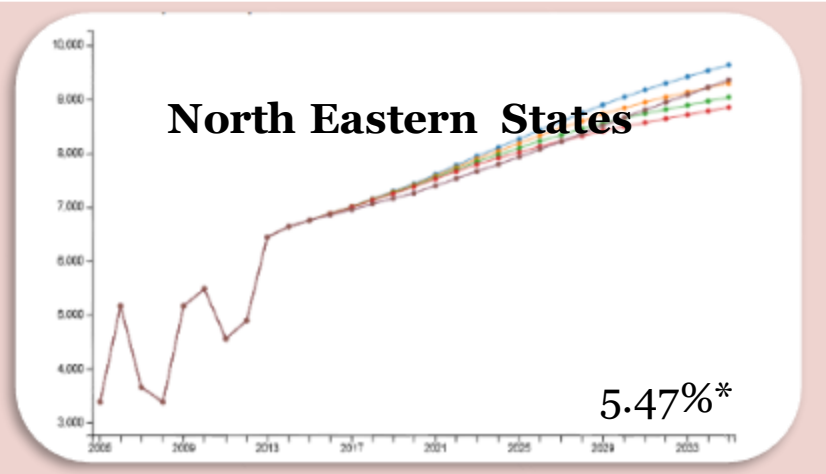
Idiom Edited Scenarios : Four different levels of FiTs

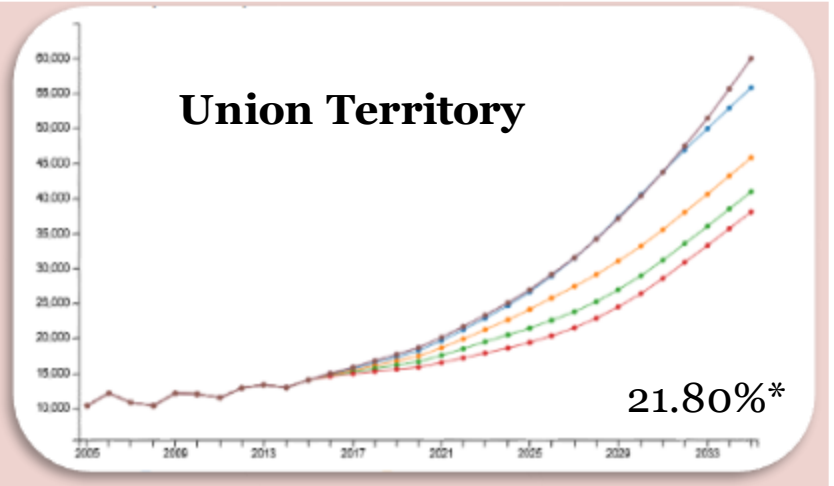
Baseline	1.1
Scenario F1	1.6
Scenario F2	2.1
Scenario F3	2.6
Scenario F4	3.1

User emission of CO2 emissions per thousand tones of Carbon









Fbase , F1, F2, F3 , F4

* Highest Percentage decrease in CO_2 emission from the baseline scenario

- Higher FiT rates in high RET states or remote northeastern states do not show a significant reduction in CO_2 emissions

- Similar incentives for low-RET states or Union Territories lead to a fairly large reduction in carbon intensity of 36.55 percent and 21.80 percent respectively

- Appropriate incentives in RET policies for union territories or late movers states can play a greater role for GHG reductions for India

Exploring Economy Energy Environmental (E3) Framework

- ***Integration of the technology transition scenarios with key economic state level parameters***

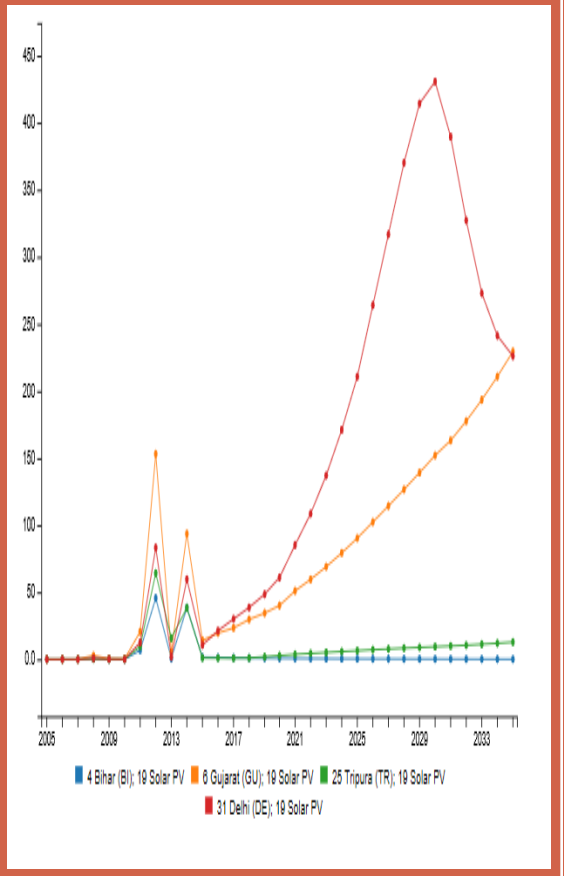
I. MWIY: Investment in new generation capacity (M INR) for representative high (Gujarat) and low-RET states (Bihar), remote north eastern states(Tripura) and Union Territories (Delhi)

- ***Trend Simulation for Key Economic Parameters in four representative of state categories***

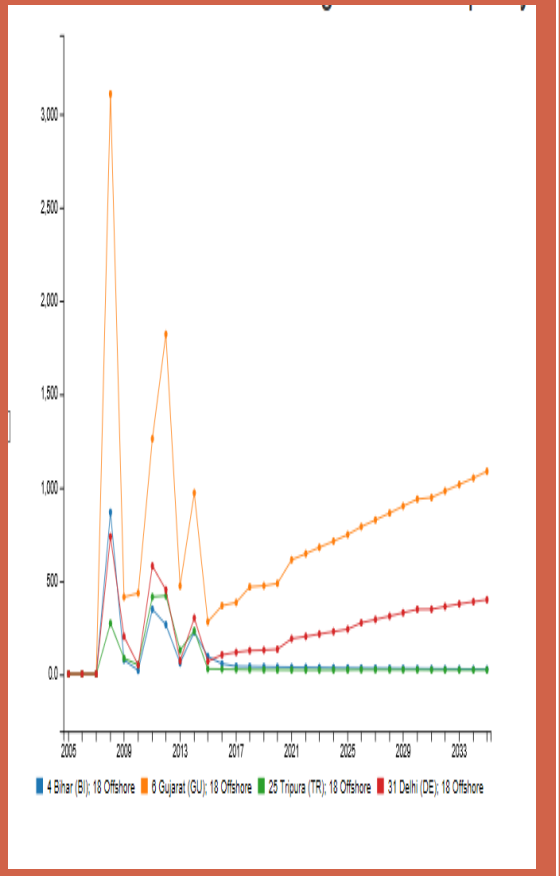
I. GDP measure at market price (RGDP)
II. Regional Total Consumer expenditure (RSC)
III. Regional Total Investment spending (RSK)

Investments in New generation Capacity (M 2000 $)

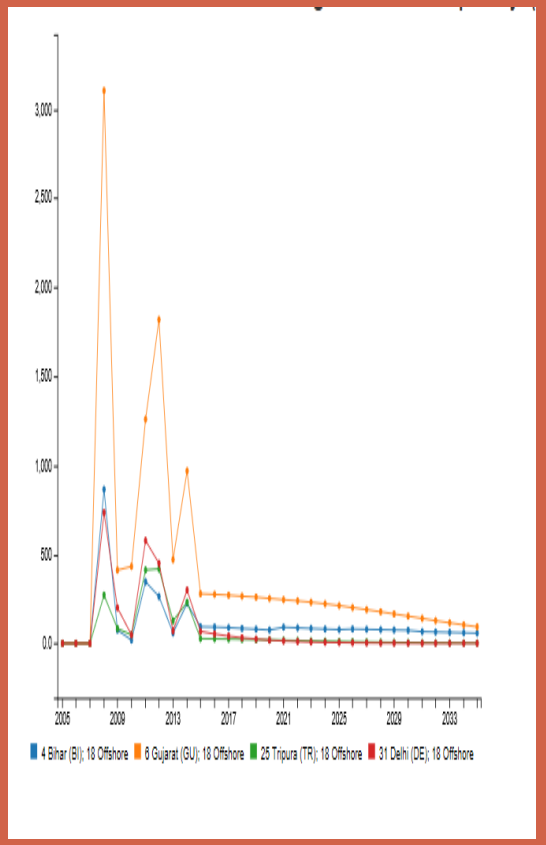
Solar PV



Wind On shore



Solid Biomass



Bihar, Gujarat, Tripura, Delhi

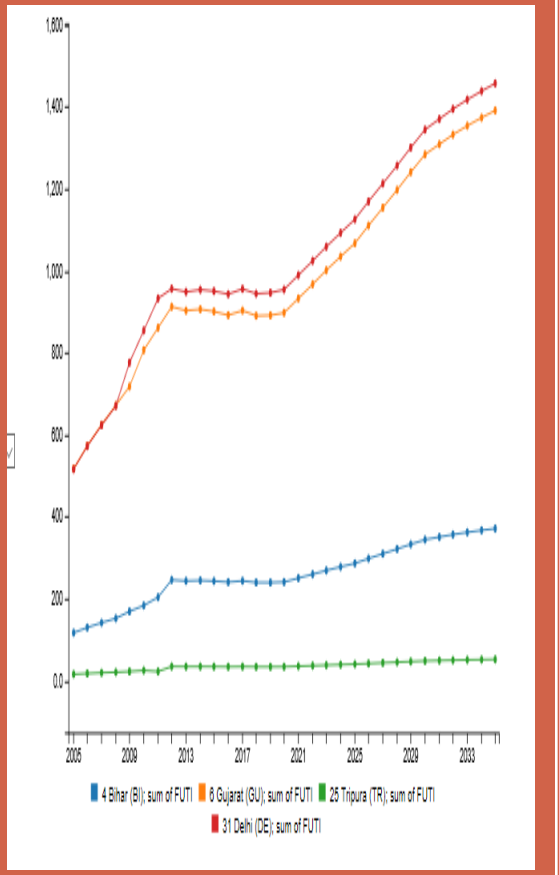
- The trend indicates high investments in solid Biomass and onshore wind in earlier years followed by constant low investments

- Investments for solar PV show a greater positive investment trajectory over time

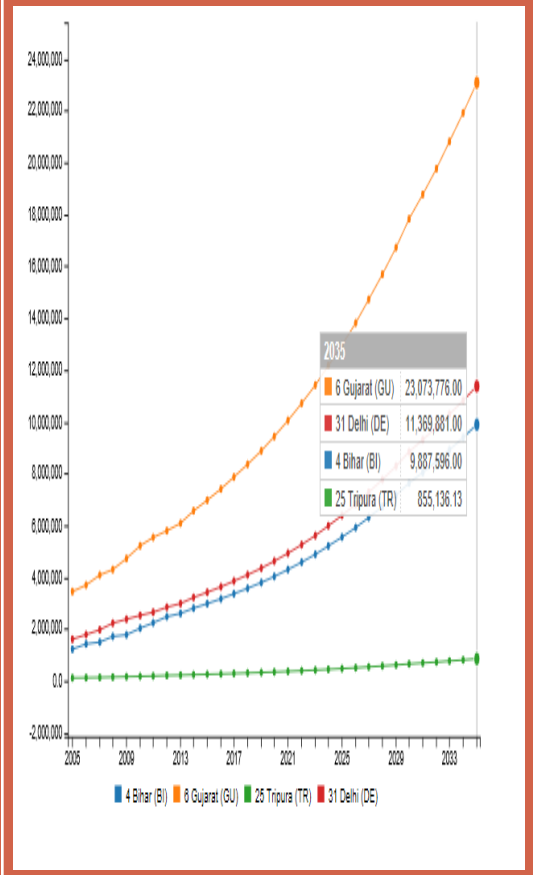
- The investments for solar PV and onshore wind has higher growth rate in High RET states and Union territories

Trends in Regional economic parameters (2005-2035)

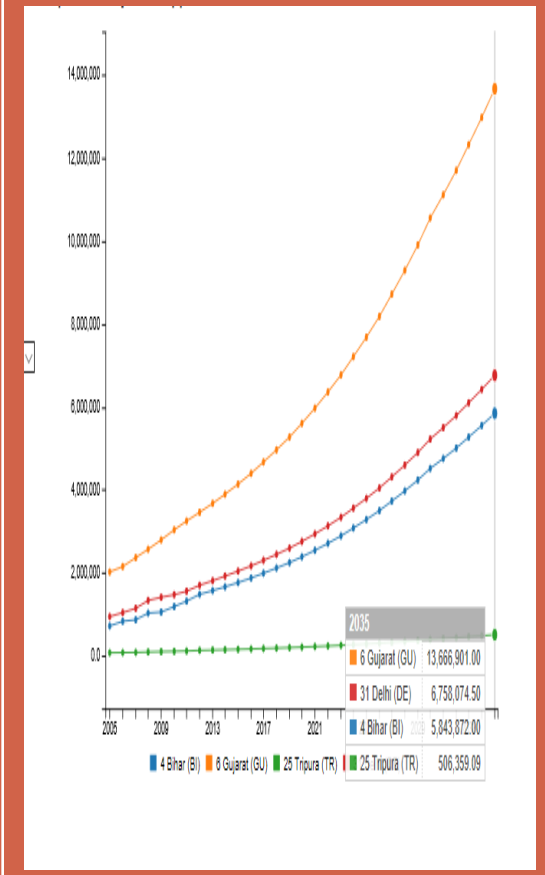
GDP at market price (2010 INR)



Consumer Expenditure (2010 INR)



Investment Spending (2010 INR)



- Higher GDP generation for High RET states and Union territory followed by low RET states and North eastern states

- The regional consumption expenditure and investments increase with time but the trajectory is dependent on the differentiated category of the states with high RET states and Union Territories being the leaders

CONCLUSIONS

- Effective flexibility for regionally differentiated analysis at state level in India
- FTT component effectively integrated inputs for new policy scenarios and generated results with respect to existing baseline
- Economic variables linked with energy or environment policy could be effectively simulated
- Baseline state level economic parameters are well differentiated and can be effectively simulated using the model
- E-3 India (B3 version) demonstrates capability of an effective tool for state level policy simulation in India

Thank you !