Employment considerations in energy transitions

Aman MALIK

RD3 PhD Seminar

27.04.2021

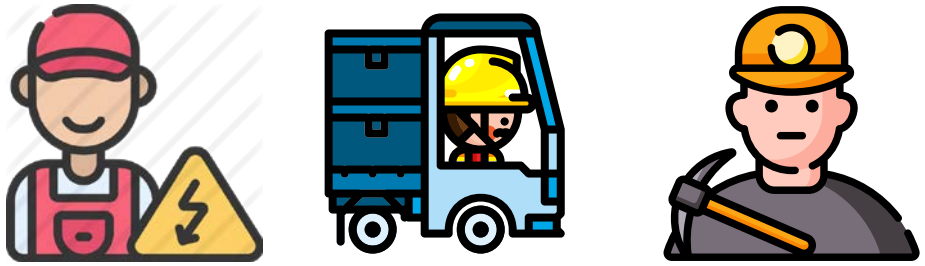
Potsdam Institute for Climate Impact Research

Employment and energy transitions

- Employment is key in any policy-making, including decarbonization policies
- Country-wide or macroeconomic aspects
  - Difficult to estimate
  - Connections with many sectors; focus on **core energy sector.**
  - Energy sector employment ~1.2% of total global employment
  - 3.3 billion vs. 40 million total world direct energy jobs
  - Despite the insignificant share, core energy sector jobs are **directly linked** to energy policy, are a source of **indirect job creation** and **important revenue** for states.
- Regional aspects
  - **Just transition** - ease political opposition, broaden societal goals beyond climate, and long-term socio-economic effects.

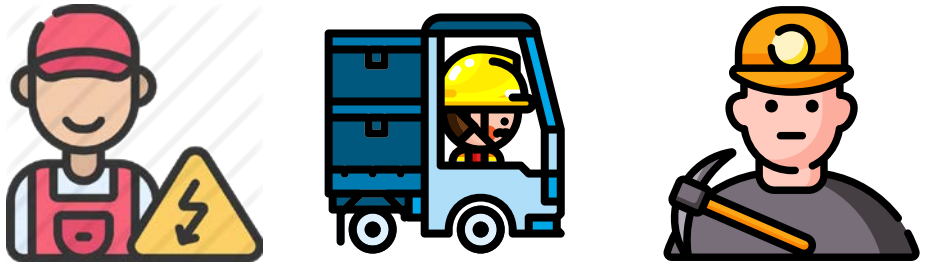
Employment and energy transitions

- Employment is key in any policy-making, including decarbonization policies
- Country-wide or macroeconomic aspects
  - Difficult to estimate
  - Connections with many sectors; focus on **core energy sector.**
  - Energy sector employment ~1.2% of total global employment
  - 3.3 billion vs. 40 million total world direct energy jobs
  - Despite the insignificant share, core energy sector jobs are **directly linked** to energy policy, are a source of **indirect job creation** and **important revenue** for states.
- Regional aspects
  - **Just transition** - ease political opposition, broaden societal goals beyond climate, and long-term socio-economic effects.



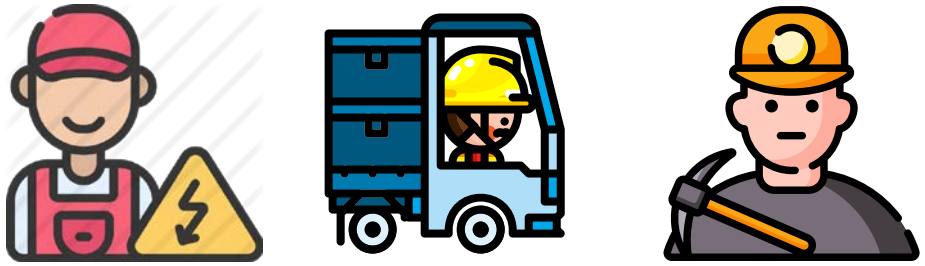
Employment and energy transitions

- Employment is key in any policy-making, including decarbonization policies
- Country-wide or macroeconomic aspects
  - Difficult to estimate
  - Connections with many sectors; focus on **core energy sector.**
  - Energy sector employment ~1.2% of total global employment
  - 3.3 billion vs. 40 million total world direct energy jobs
  - Despite the insignificant share, core energy sector jobs are **directly linked** to energy policy, are a source of **indirect job creation** and **important revenue** for states.
- Regional aspects
  - **Just transition** - ease political opposition, broaden societal goals beyond climate, and long-term socio-economic effects.



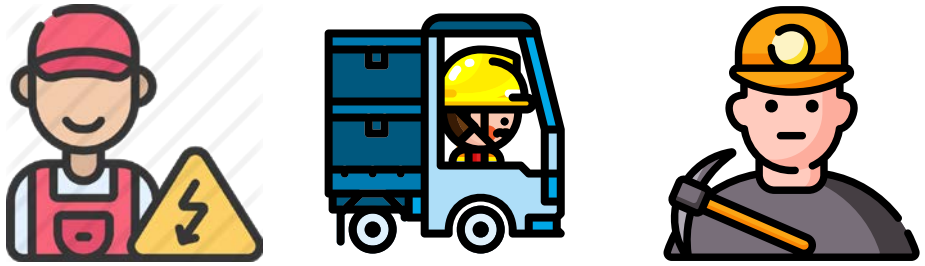
Employment and energy transitions

- Employment is key in any policy-making, including decarbonization policies
- Country-wide or macroeconomic aspects
  - Difficult to estimate
  - Connections with many sectors; focus on **core energy sector.**
  - Energy sector employment ~1.2% of total global employment
  - 3.3 billion vs. 40 million total world direct energy jobs
  - Despite the insignificant share, core energy sector jobs are **directly linked** to energy policy, are a source of **indirect job creation** and **important revenue** for states.
- Regional aspects
  - **Just transition** - ease political opposition, broaden societal goals beyond climate, and long-term socio-economic effects.



Employment and energy transitions

- Employment is key in any policy-making, including decarbonization policies
- Country-wide or macroeconomic aspects
  - Difficult to estimate
  - Connections with many sectors; focus on **core energy sector.**
  - Energy sector employment ~1.2% of total global employment
  - 3.3 billion vs. 40 million total world direct energy jobs
  - Despite the insignificant share, core energy sector jobs are **directly linked** to energy policy, are a source of **indirect job creation** and **important revenue** for states.
- Regional aspects
  - **Just transition** - ease political opposition, broaden societal goals beyond climate, and long-term socio-economic effects.



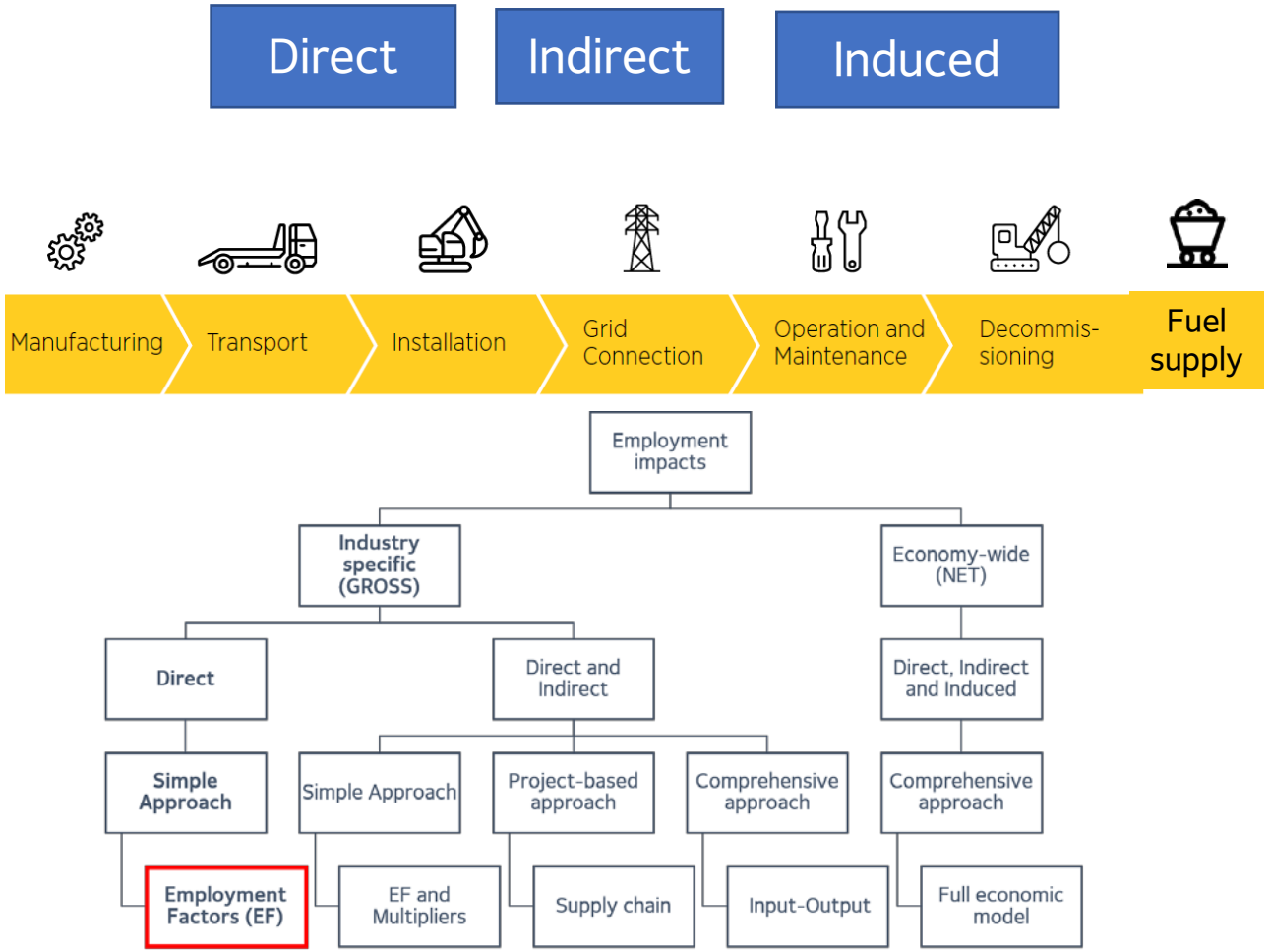
Employment and energy transitions

- Employment is key in any policy-making, including decarbonization policies
- Country-wide or macroeconomic aspects
  - Difficult to estimate
  - Connections with many sectors; focus on **core energy sector.**
  - Energy sector employment ~1.2% of total global employment
  - 3.3 billion vs. 40 million total world direct energy jobs
  - Despite the insignificant share, core energy sector jobs are **directly linked** to energy policy, are a source of **indirect job creation** and **important revenue** for states.
- Regional aspects
  - **Just transition** - ease political opposition, broaden societal goals beyond climate, and long-term socio-economic effects.

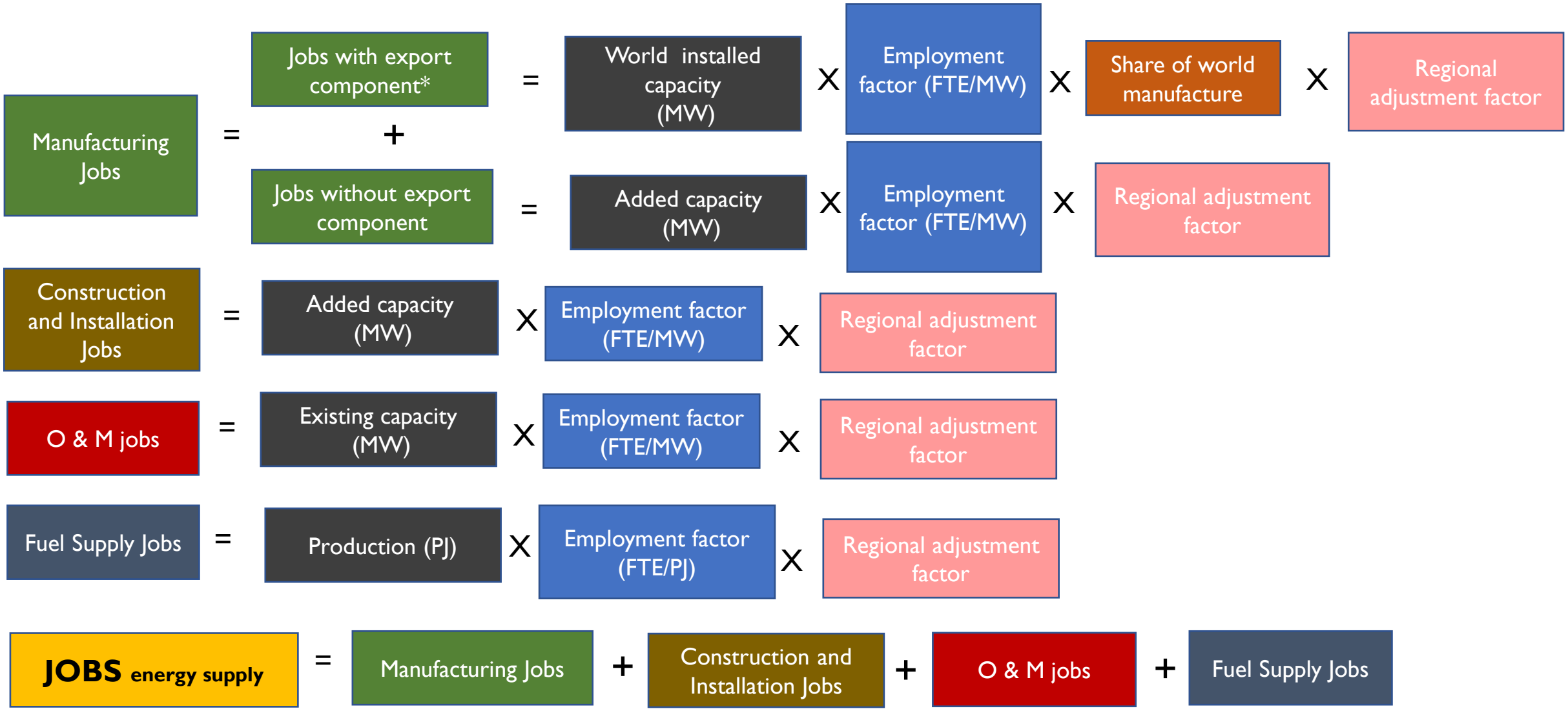
1. Drivers of global energy employment in mitigation scenarios

Methodology

- Only direct jobs – *related to core industry* in the energy supply sector.
- Across the value chain, divided into Manufacturing, Construction and Installation (CI), Operation and Maintenance (O & M), and Fuel supply/Extraction.
- Uses an updated employment factor approach, ex –post on REMIND scenarios



Employment factor approach



* Only includes solar pv and wind

Based on Rutovitz et al., 2015

Scope

What is covered?

Coal
Gas
Oil
Biomass
Nuclear
Solar PV
Wind
Hydro
Solar CSP

Divided into *solar pv rooftop and utility*, *wind onshore and offshore* and *small and large hydro* through an external share parameter.

What is not covered?

- Transmission and distribution
- Battery-storage
- Decommissioning
- Coal, oil, gas jobs do not include refining, transportation, and distribution.
- Jobs in heat industry
- Energy-efficiency jobs

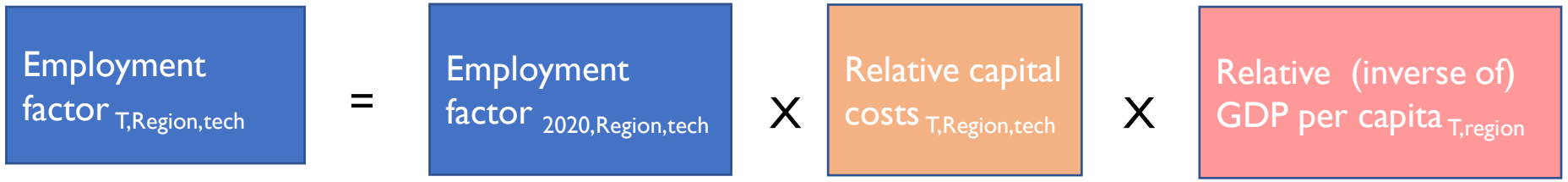
Scenario setup

Policy scenarios

Scenario name	Scenario description
NDC	Reaching NDC targets in 2030 via iteratively adjusted carbon prices, assuming gradual convergence at average prices thereafter.
1.5C	Constraint in carbon budget (900 GtCO2) from 2011-peak of CO2 emissions; ~ 66% chance below 1.5°C end of century

Evolvement of capacity factors

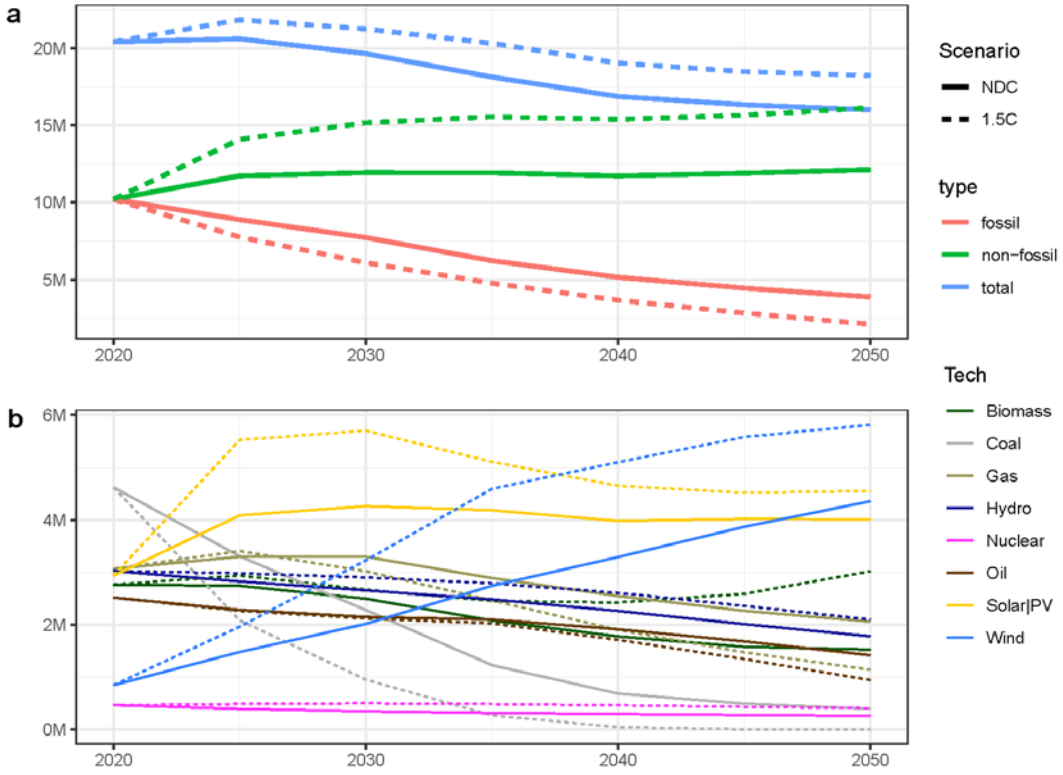
- Labour productivity (LP) – shifts in methods of production ~ GDP per capita
- Capital costs – maturity of technology, economies of scale

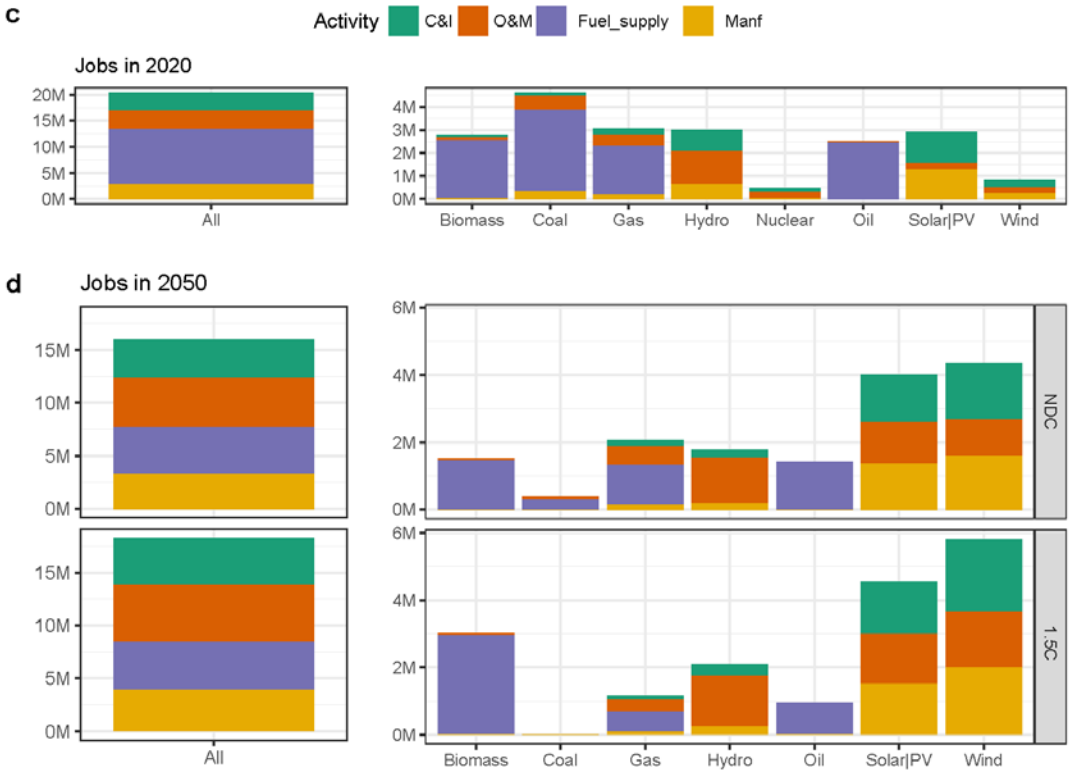


Employment factors for extraction sector (except coal remain static)

RESULTS

- In the long run, improvements in labour productivity lead to a **decrease** of total direct energy employment compared to today, however, total jobs are still **higher in a 1.5°C** scenario.
- Direct energy jobs **peak in 2025**.
- Operation and maintenance jobs **dominate** future energy supply jobs, replacing fuel supply jobs.

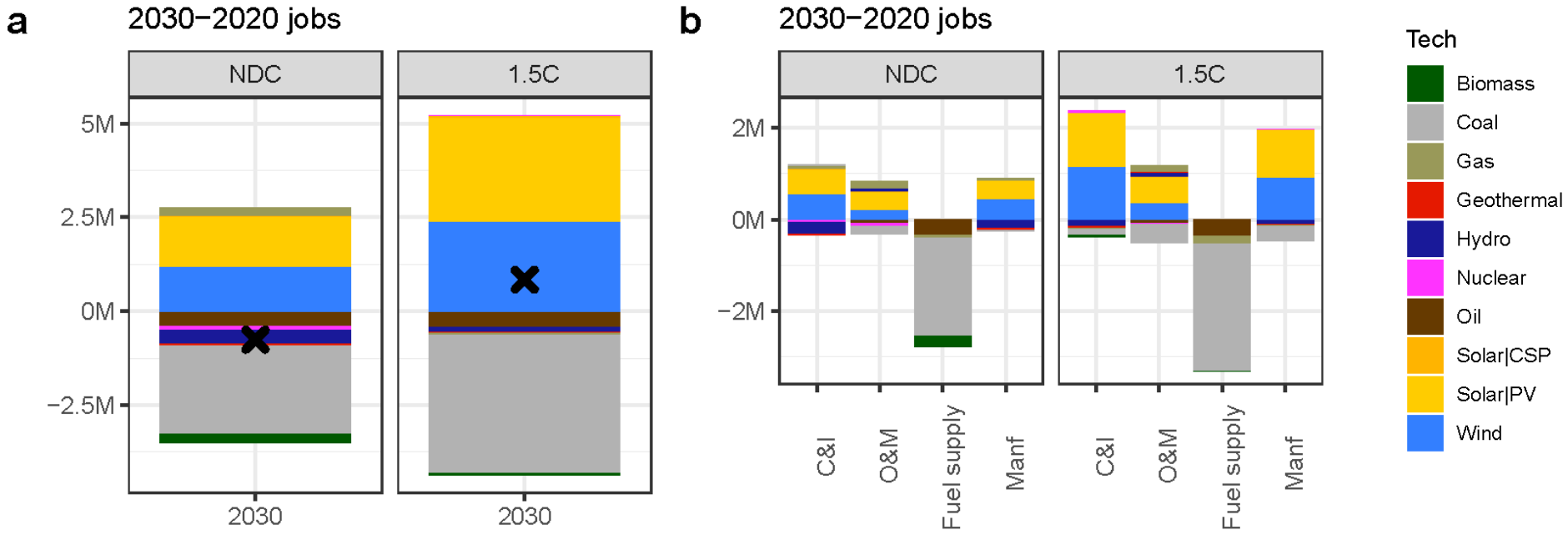




Malik et al., 2021 (in review)

RESULTS

In the near-term, **stringent mitigation** leads to a **net increase** in jobs, compared to the NDC scenario - gained through solar and wind jobs in construction, installation, and manufacturing, in spite of significant losses in coal fuel supply jobs.



Malik et al., 2021 (in review)

Conclusions

- Climate policy accelerates structural changes in global energy employment
  - move to C & I and Manufacturing jobs in near-term compensates loss in fossil jobs
  - Long term shift to O & M jobs in solar and wind

- Employment factors and how they evolve play an important role in absolute jobs and how these change in the future.

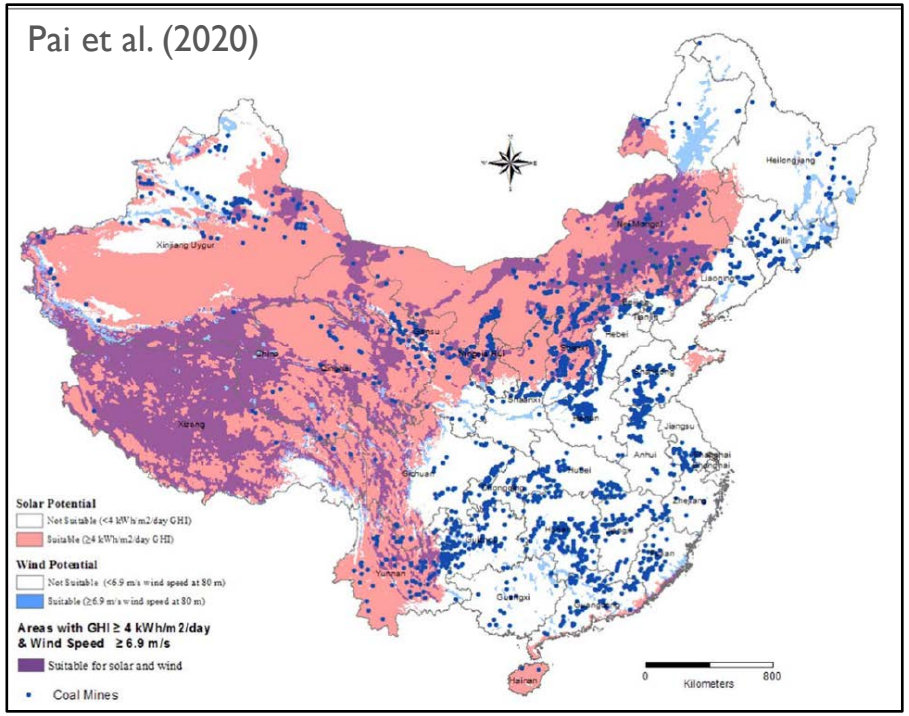
2. Just transition in India

Just transition – link between political economy and employment

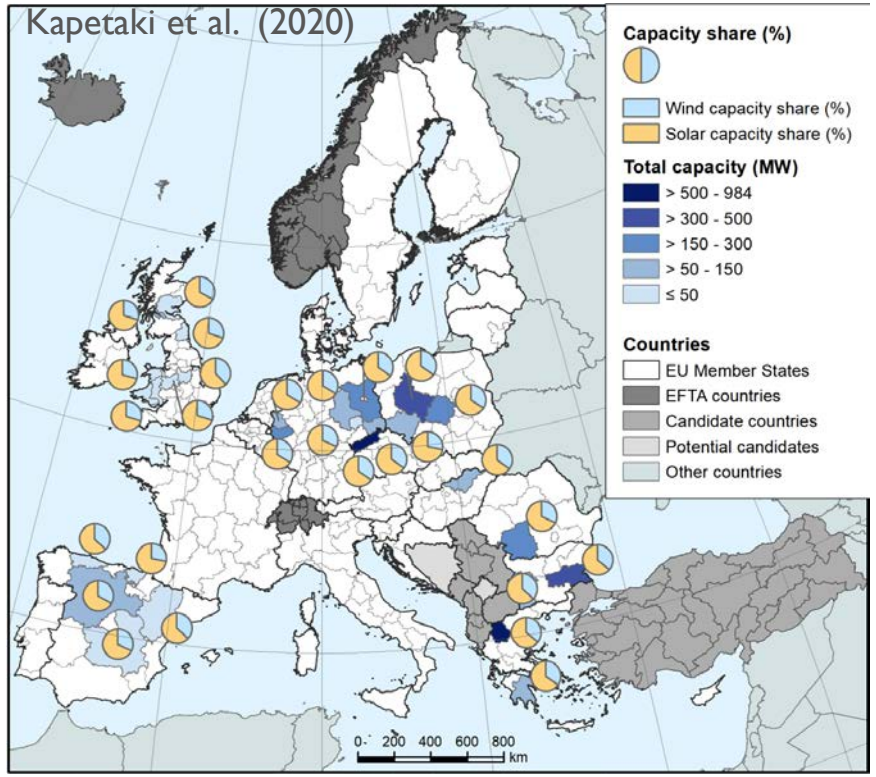
Need for national studies

- Regional concentration of resources
- RE potentials in these regions
- Re-training potential of coal workers
- Historical importance
- Source of revenue and regional development

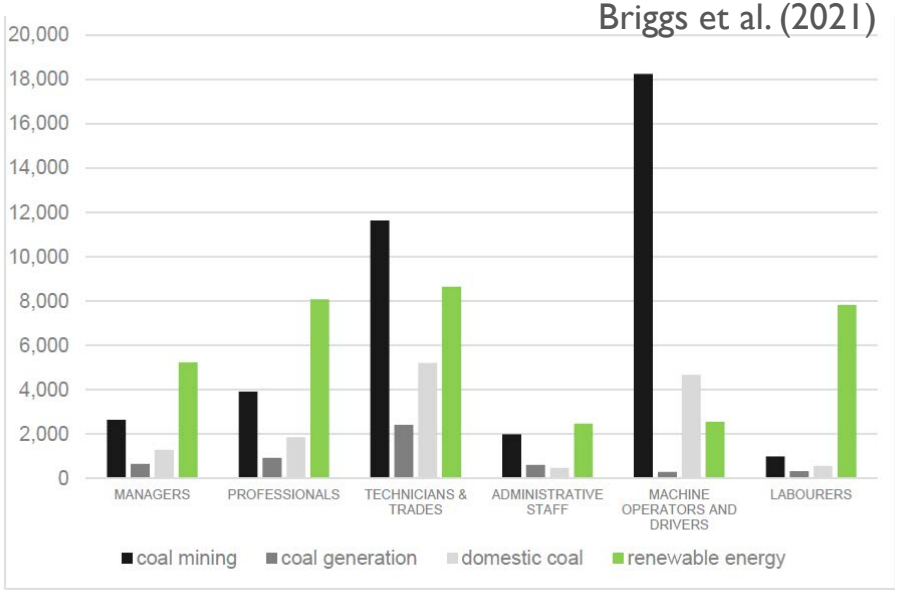
Pai et al. (2020)



Kapetaki et al. (2020)



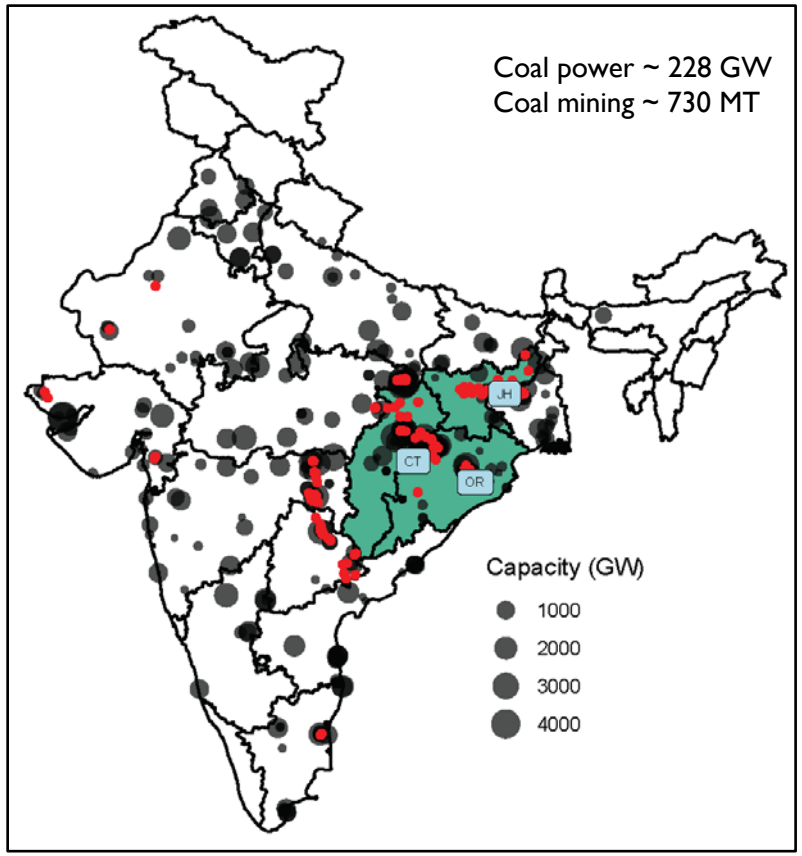
Briggs et al. (2021)



Coal and India

- Important source of energy sufficiency
  - Provides half of total energy demand and three-quarters of total electricity generated.
- Coal mines concentrated in a few states
  - Four states control ~77% of the share - Chhattisgarh (22%), Odisha (20%), Jharkhand (19%) and Madhya Pradesh (16 %)
- Mining and generation largely government owned; recently liberalised
  - 80 % of total coal mined (through Coal India Limited) and 62% of all coal power plants are government owned.
- Mining - source of regional development and employment
  - Employs ~ 450,000 people.
  - Contribute ~9% of state GDP for some states
  - Cross-subsidisation of rail freight and passenger transport

Operating coal mines + power plants



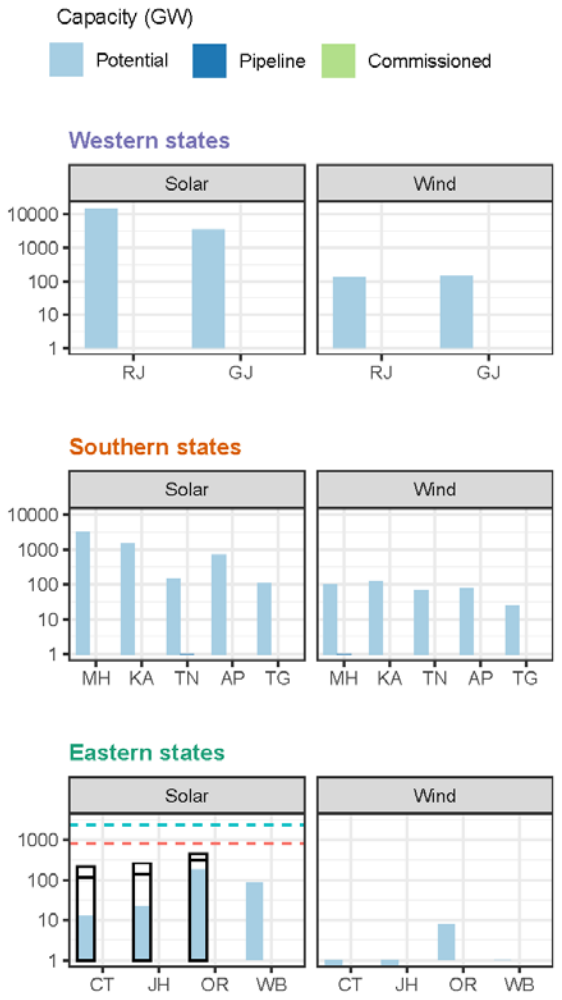
Malik and Bertram, 2021 (submitted)

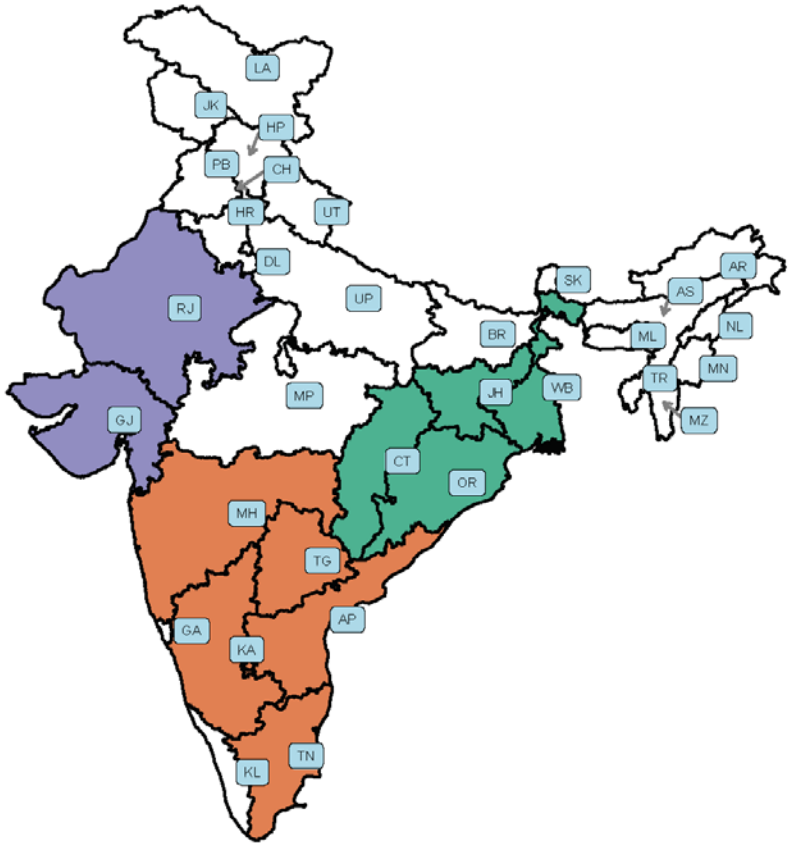
Need for just transition policies

- Solar and wind potential concentrated in western and southern states

- Installation and under-construction projects largely follow potentials
  - Higher resource quality
  - Suitable areas – large wastelands
  - Failure of rooftop policy

- Without additional distribution policies, RE installations follow current patterns. Why?
  - Potentials >> Projected all-India installation in deep decarbonization scenarios.
  - Demand centres in west and south, coal power more expensive than RE.





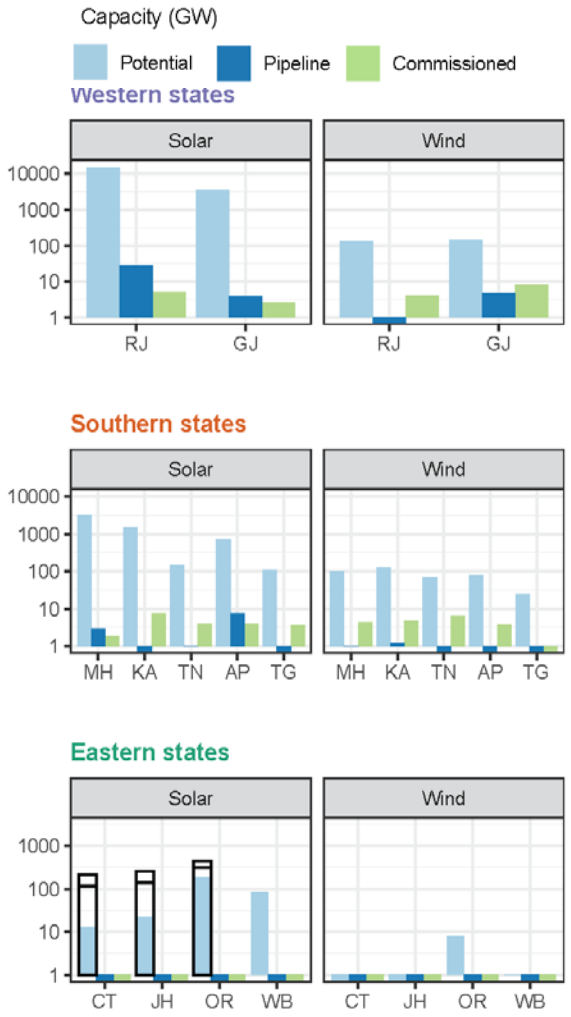
Malik and Bertram, 2021 (submitted)

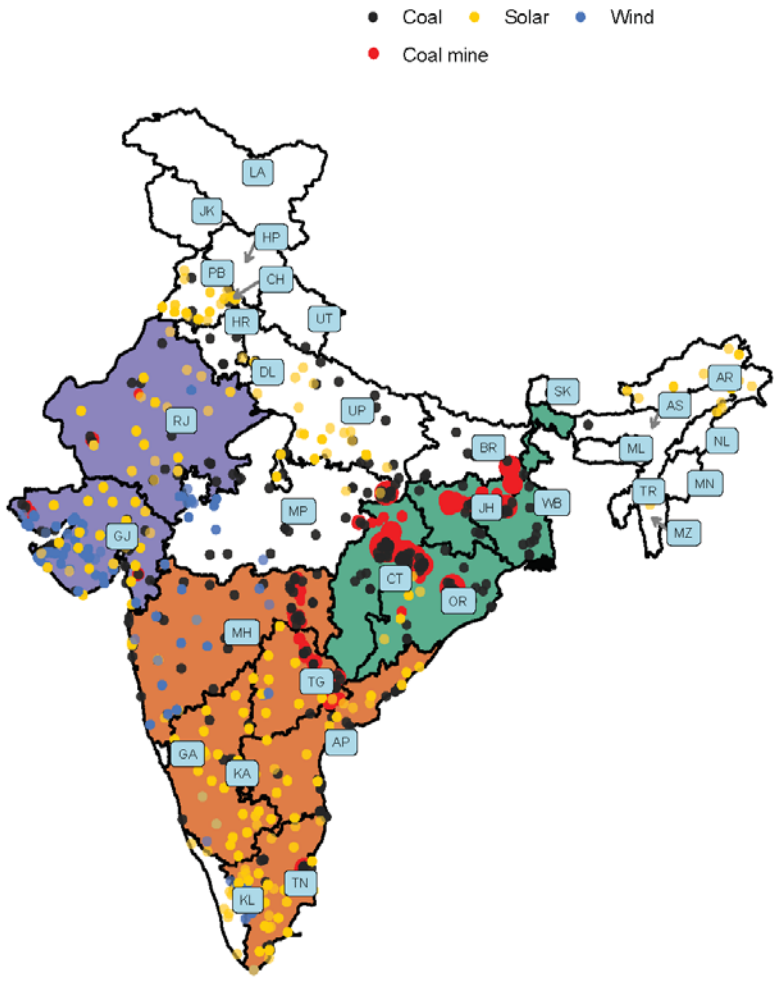
Need for just transition policies

- Solar and wind potential concentrated in western and eastern states

- Installation and under-construction projects largely follow potentials
  - Higher resource quality
  - Suitable areas – large wastelands
  - Failure of rooftop policy

- Without additional distribution policies, RE installations follow current patterns. Why?
  - Potentials >> Projected all-India installation in deep decarbonization scenarios.
  - Demand centres in west and south, coal power more expensive than RE.





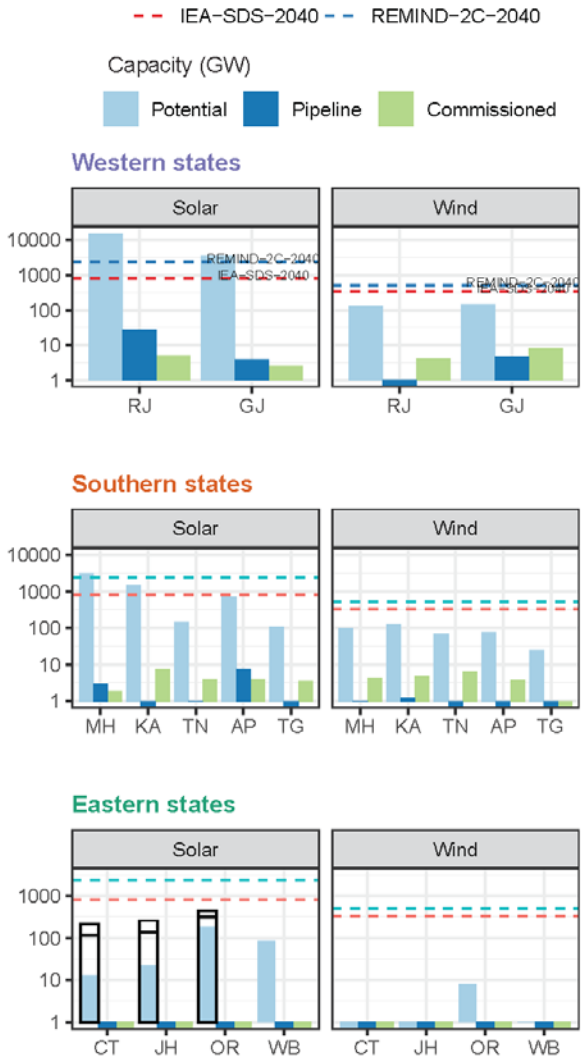
Malik and Bertram, 2021 (submitted)

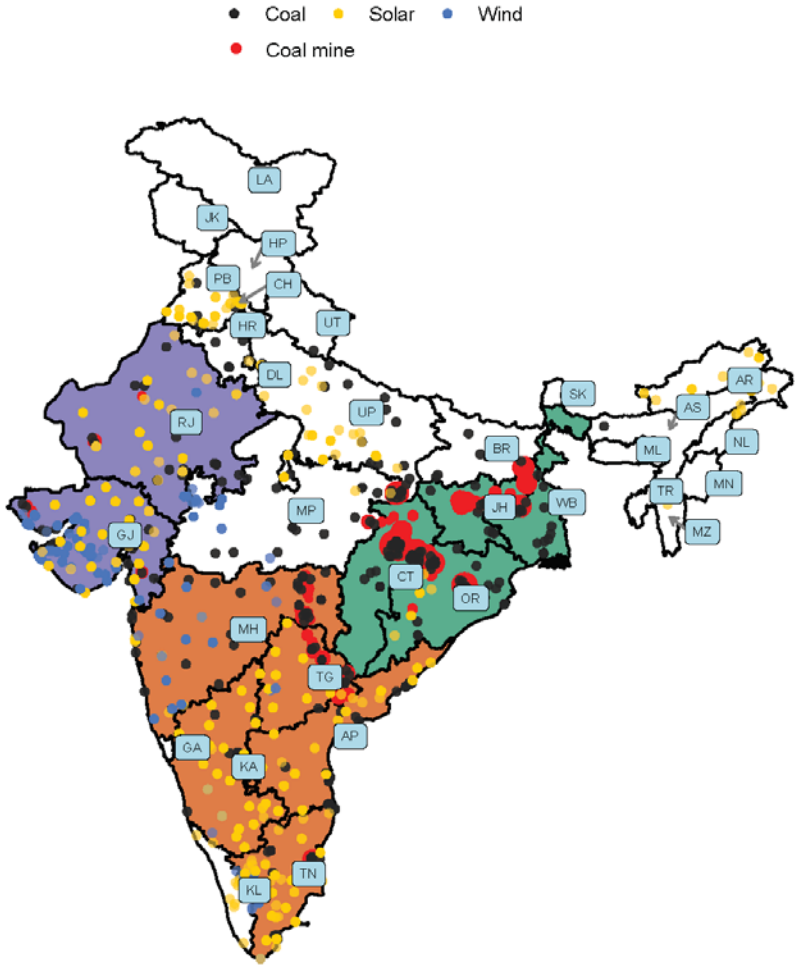
Need for just transition policies

- Solar and wind potential concentrated in western and eastern states

- Installation and under-construction projects largely follow potentials
  - Higher resource quality
  - Suitable areas – large wastelands
  - Failure of rooftop policy

- Without additional distribution policies, RE installations follow current patterns. Why?
  - Potentials >> Projected all-India installation in deep decarbonization scenarios.
  - Demand centres in west and south, coal power more expensive than RE.

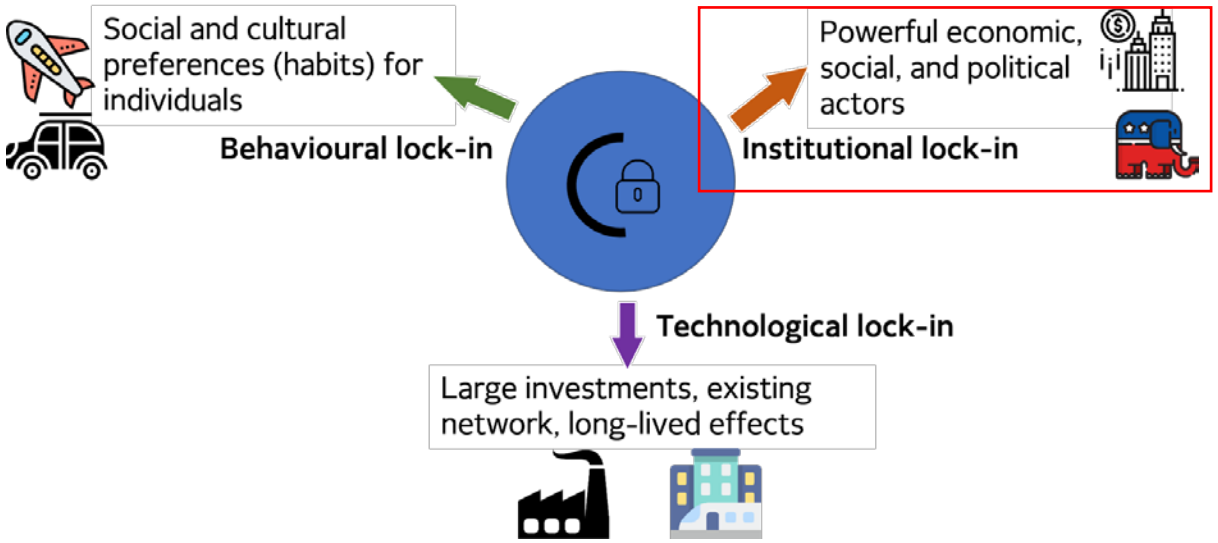




Malik and Bertram, 2021 (submitted)

Need for just transition policies

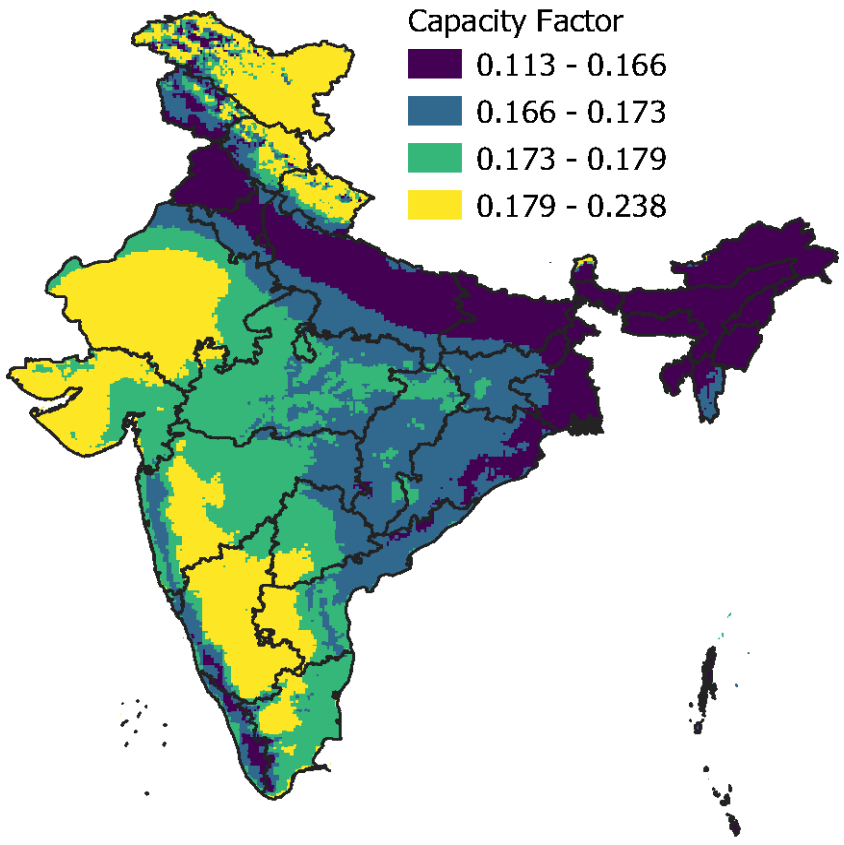
- Continued coal investments in eastern states could impair transition to RE through lock-ins
  - E.g., emission standards for coal-power successfully lobbied and delayed
- Factors affecting opposition
  - Share of formal workers
  - Importance of mining to overall state economy
  - Coal interests at multiple governance levels
- Eastern states –
  - Loss of direct and indirect employment
  - Miss benefits of decarbonised economy
  - Exacerbate inequalities between states



Based on Seto et al., 2018

Just-transition policies – role of solar

- Higher cost of solar PV in eastern states ~ 15%
- Capacity needed to replace all coal mining jobs (450k) ~ 650 GW
  - Lower if solar pv rooftop promoted
- Solar not the silver bullet; provide a nascent start to the transition
  - Benefits to larger decarbonization – distribution of RE
  - Using existing road infrastructure
  - Job creation in all regions



Conclusion

- Solar potentials in west and southern states, compared to coal-bearing eastern states, are several magnitudes higher than all-India projected RE capacity in 2030/2040, even in deep decarbonization scenarios
- Without additional policies affecting RE distribution, most of the RE would remain concentrated to the former states, exacerbating inequality and just transition in coal bearing states.
- Solar could play an small but important role in ensuring early geographic diversification of RE locations which will help build broad support for the energy transition that is required for climate targets.

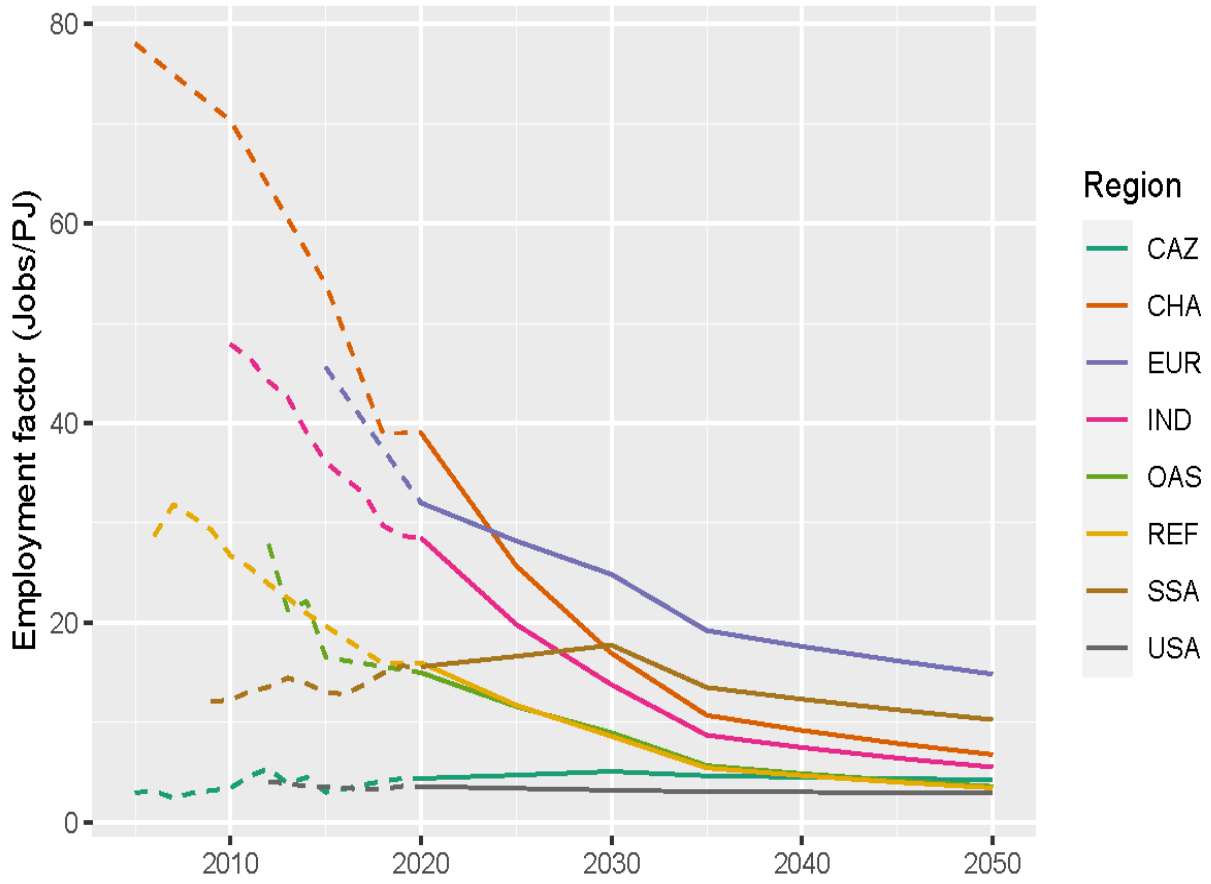
Future work

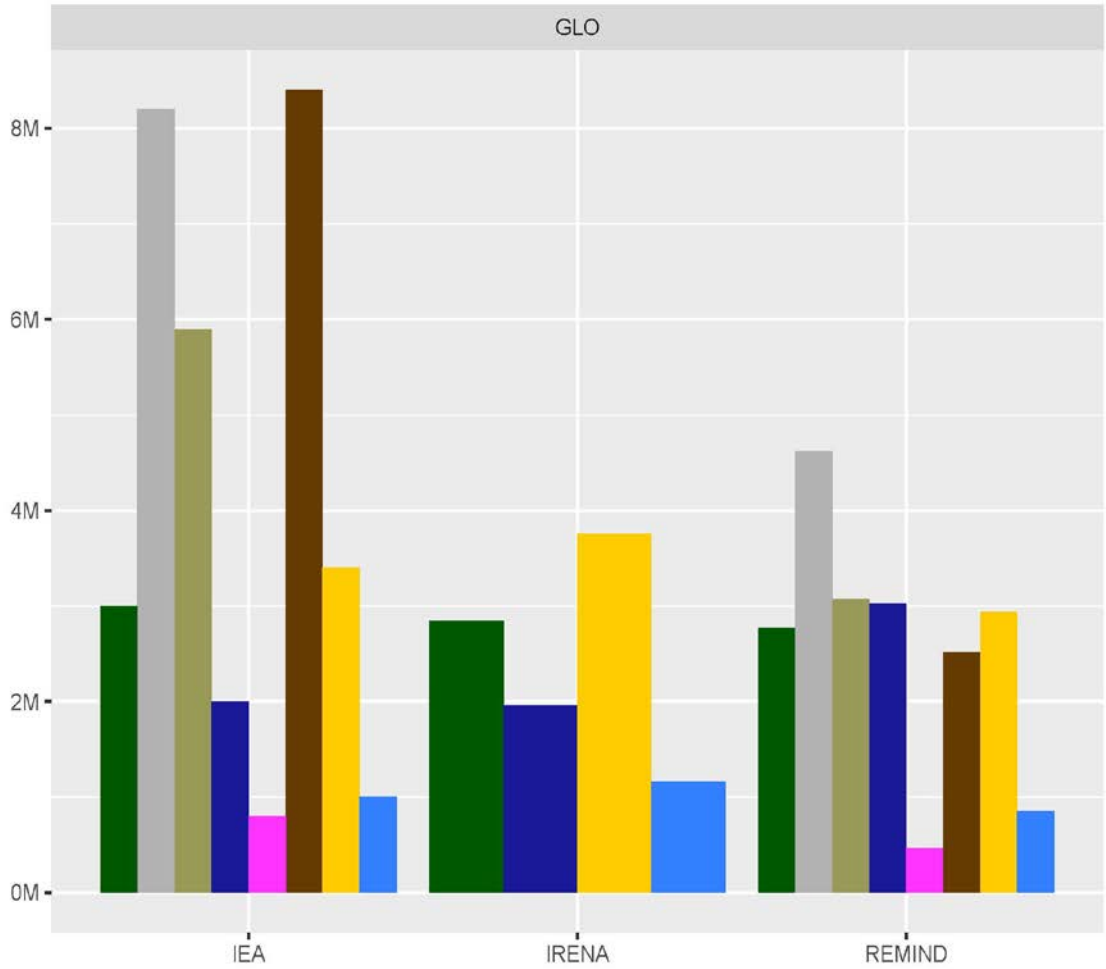
- Energy policy in India – fast developing space
  - Consistently lower solar and wind tariffs
  - Reduced power demand from Covid-19 disproportionately affected coal generation (Bertram et al., 2021) + existing stressed assets in coal = increased risk of coal investments
  - Risk of stranded assets in the power sector (Malik et al. 2020) - some RE-rich states and big private players (Tata) signalled end to coal investments
  - Pressure to strengthen ambition after US target, US-China talks
  - Increasing environmental concerns
- Explore scenario space for India between NDC and stringent mitigation, analyse impacts on -
  - Employment
  - Air pollution
  - Inequality

Questions and Comments?

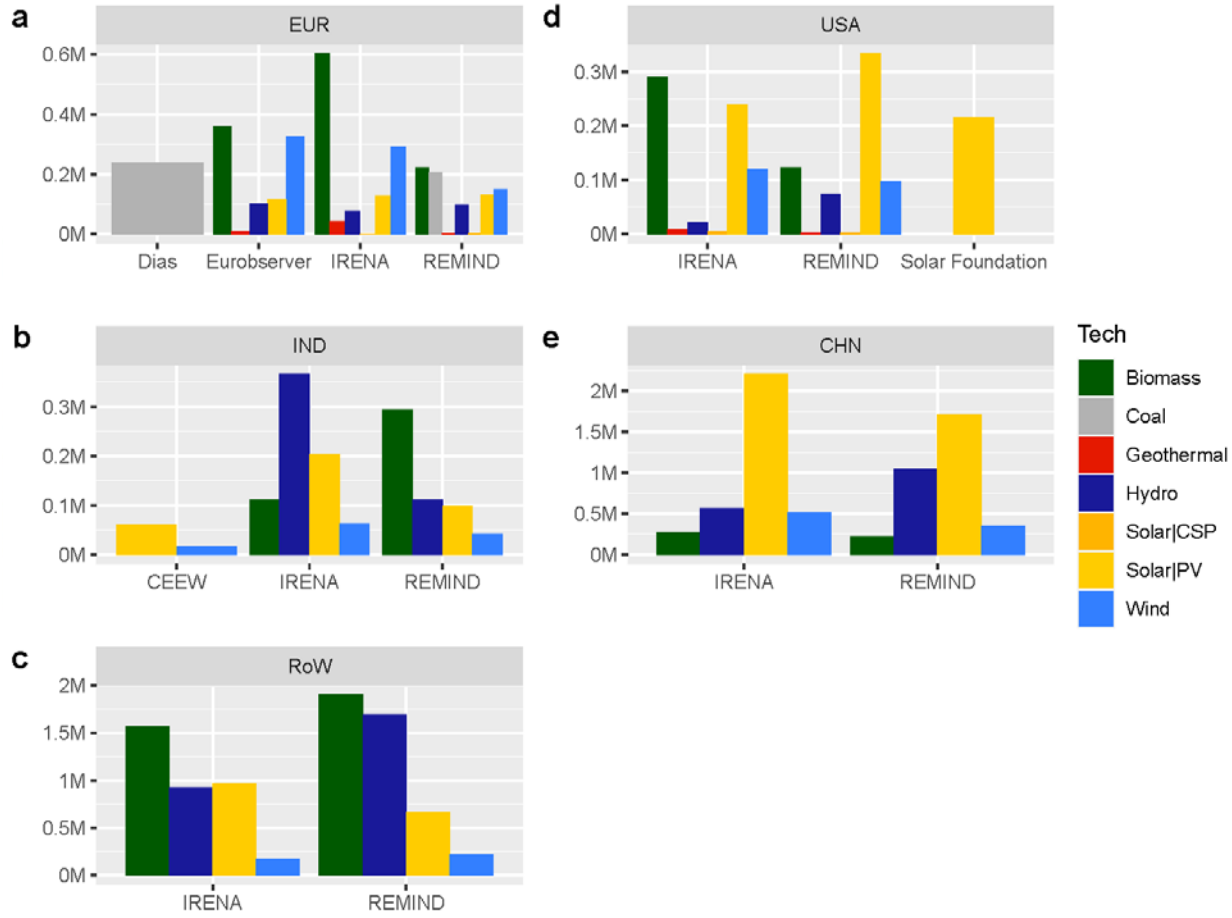
amalik@pik-potsdam.de

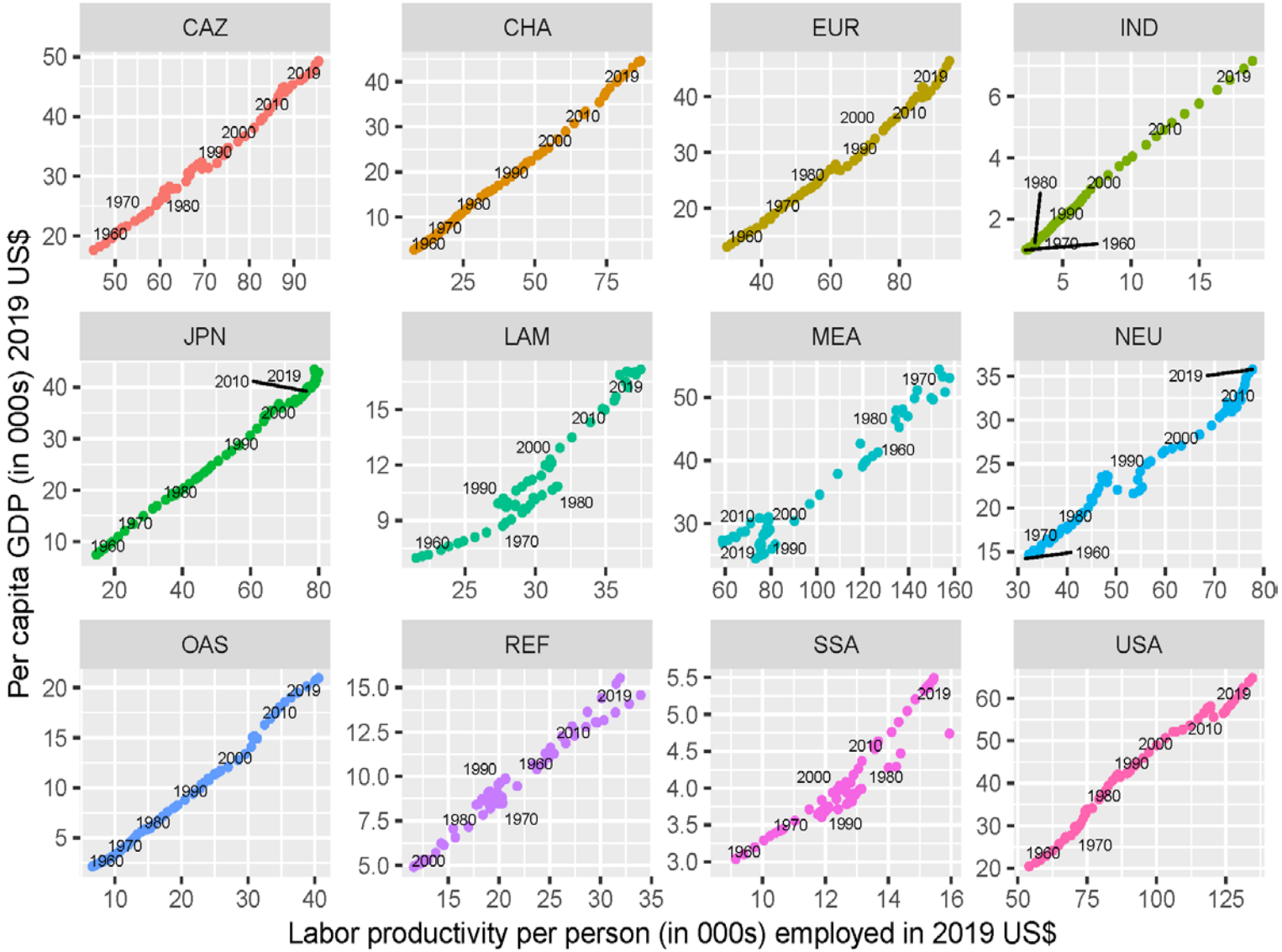
Backup

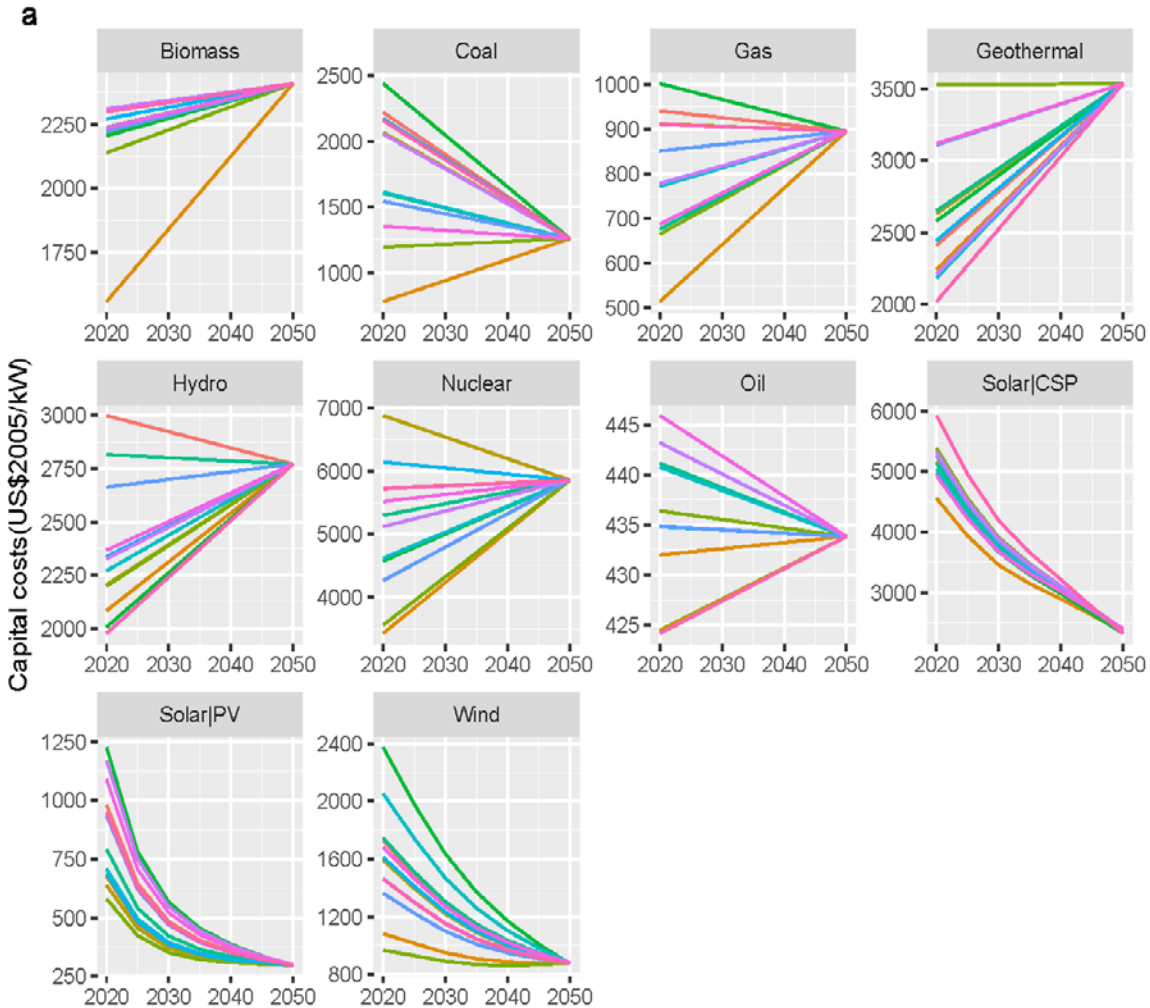

Employment factor (Jobs/PJ)
80
60
40
20
0
2010
2020
2030
2040
2050
Region
CAZ
CHA
EUR
IND
OAS
REF
SSA
USA

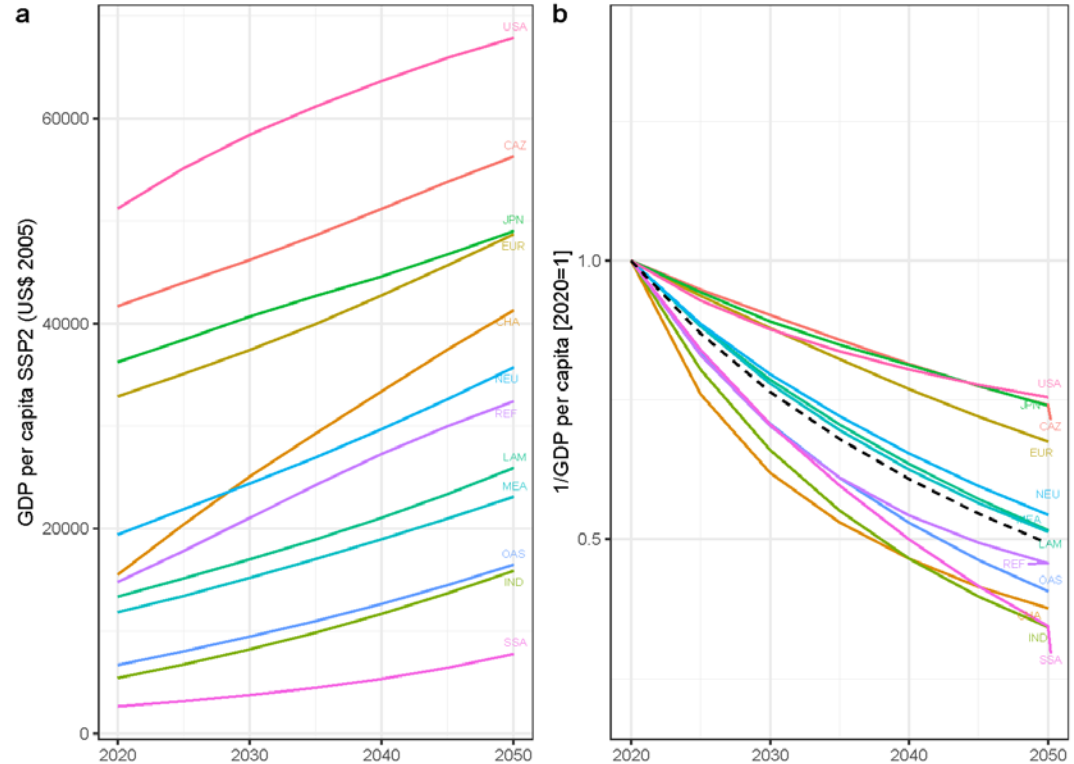


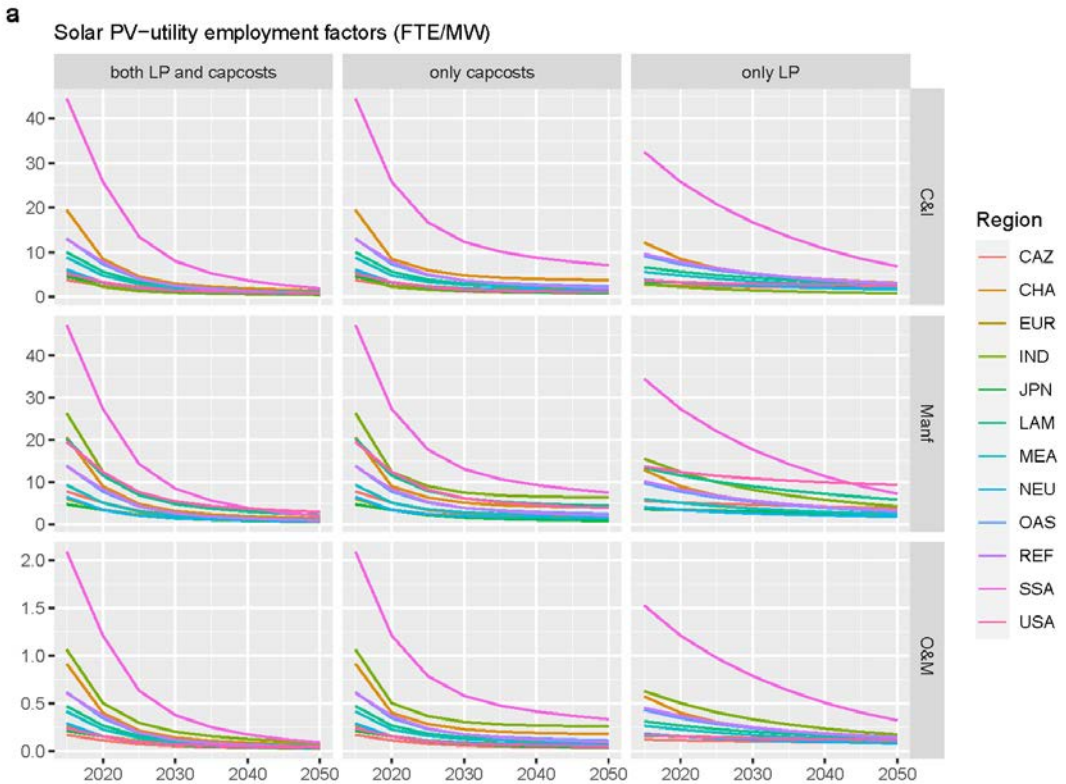
IEA and IRENA data for 2019, REMIND for 2020.
IEA includes refining, transportation, and distribution jobs for coal, oil, gas, and bioenergy;
REMIND includes only direct jobs in fuel production/extraction.
Biomass jobs for IRENA is sum of Biomass, 80% Biofuels, and 30% Biogas jobs

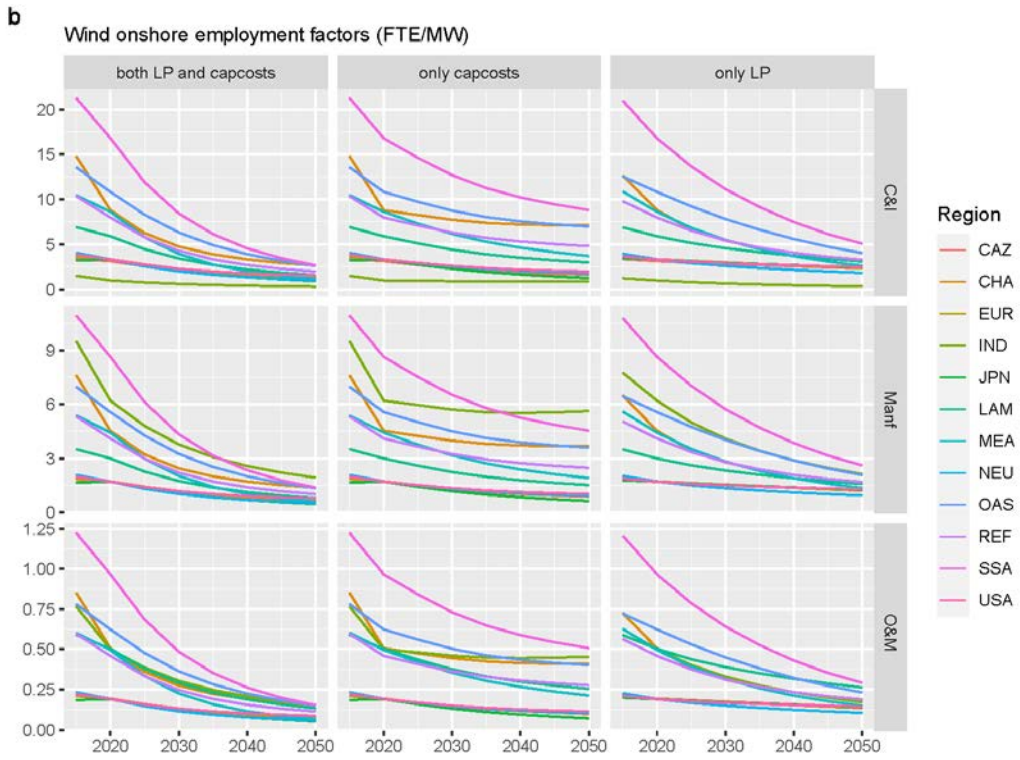


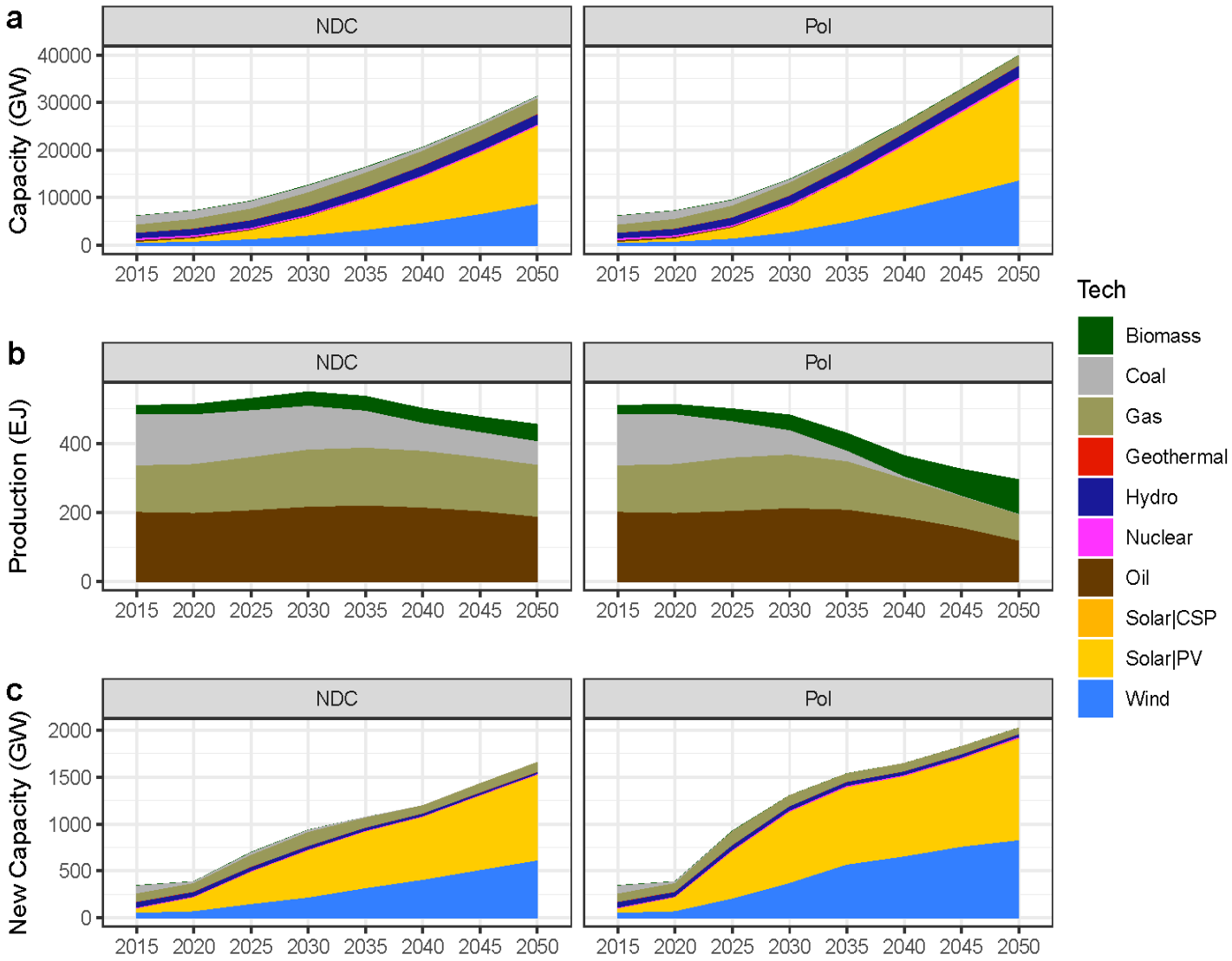

CAZ
CHA
EUR
IND
JPN
LAM
MEA
NEU
OAS
REF
SSA
USA
Per capita GDP (in 000s) 2019 US$
Labor productivity per person (in 000s) employed in 2019 US$

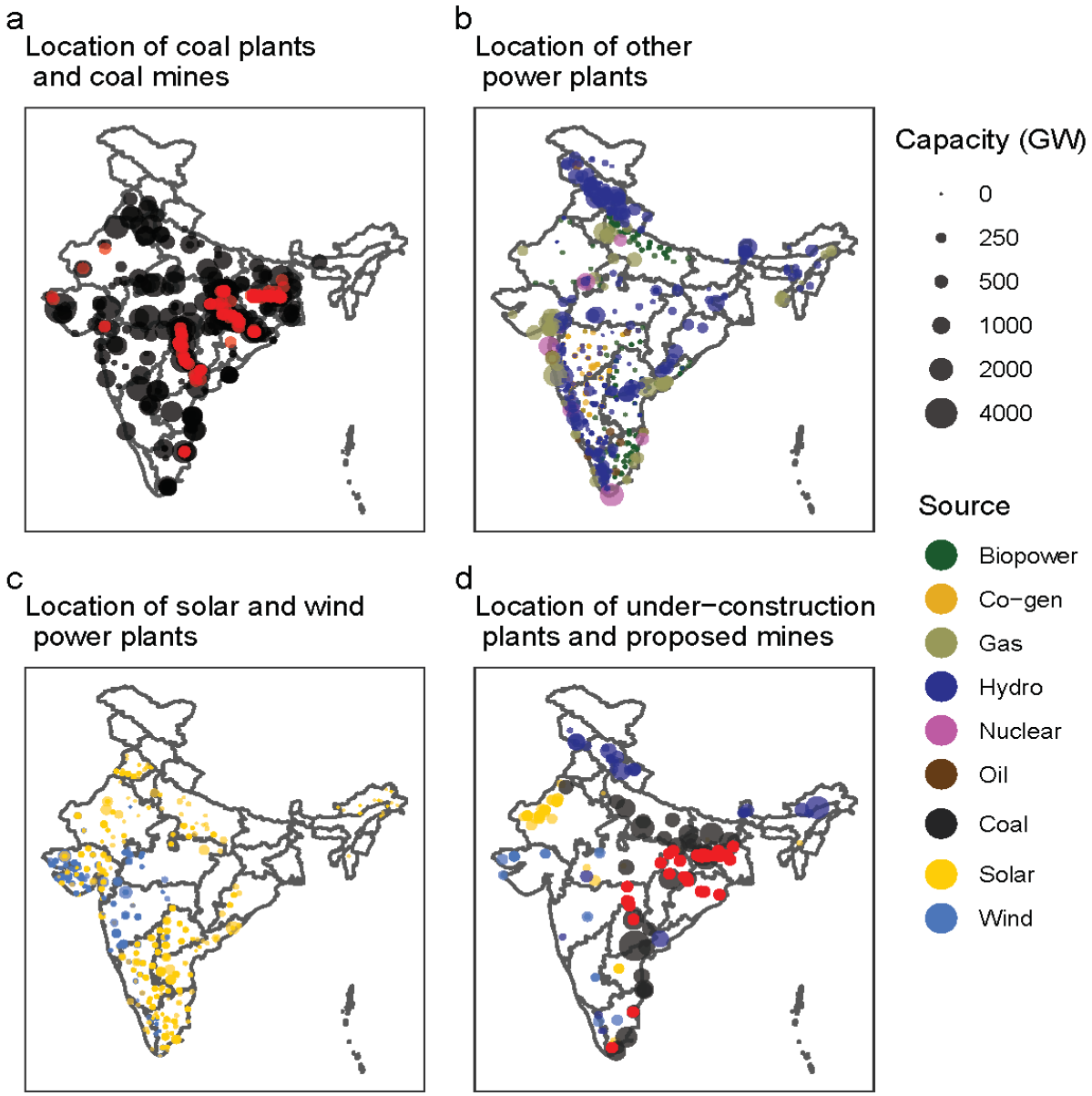

a
Biomass
Coal
Gas
Geothermal
Hydro
Nuclear
Oil
Solar|CSP
Solar|PV
Wind
Capital costs(US$2005/kW)
Region
CAZ
CHA
EUR
IND
JPN
LAM
MEA
NEU
OAS
REF
SSA
USA


a
b
GDP per capita SSP2 (US$ 2005)
1/GDP per capita [2020=1]
USA
CAZ
JPN
EUR
CHA
NEU
REF
LAM
MEA
OAS
IND
SSA


a
Solar PV−utility employment factors (FTE/MW)
both LP and capcosts
only capcosts
only LP
C&I
Manf
O&M
Region
CAZ
CHA
EUR
IND
JPN
LAM
MEA
NEU
OAS
REF
SSA
USA

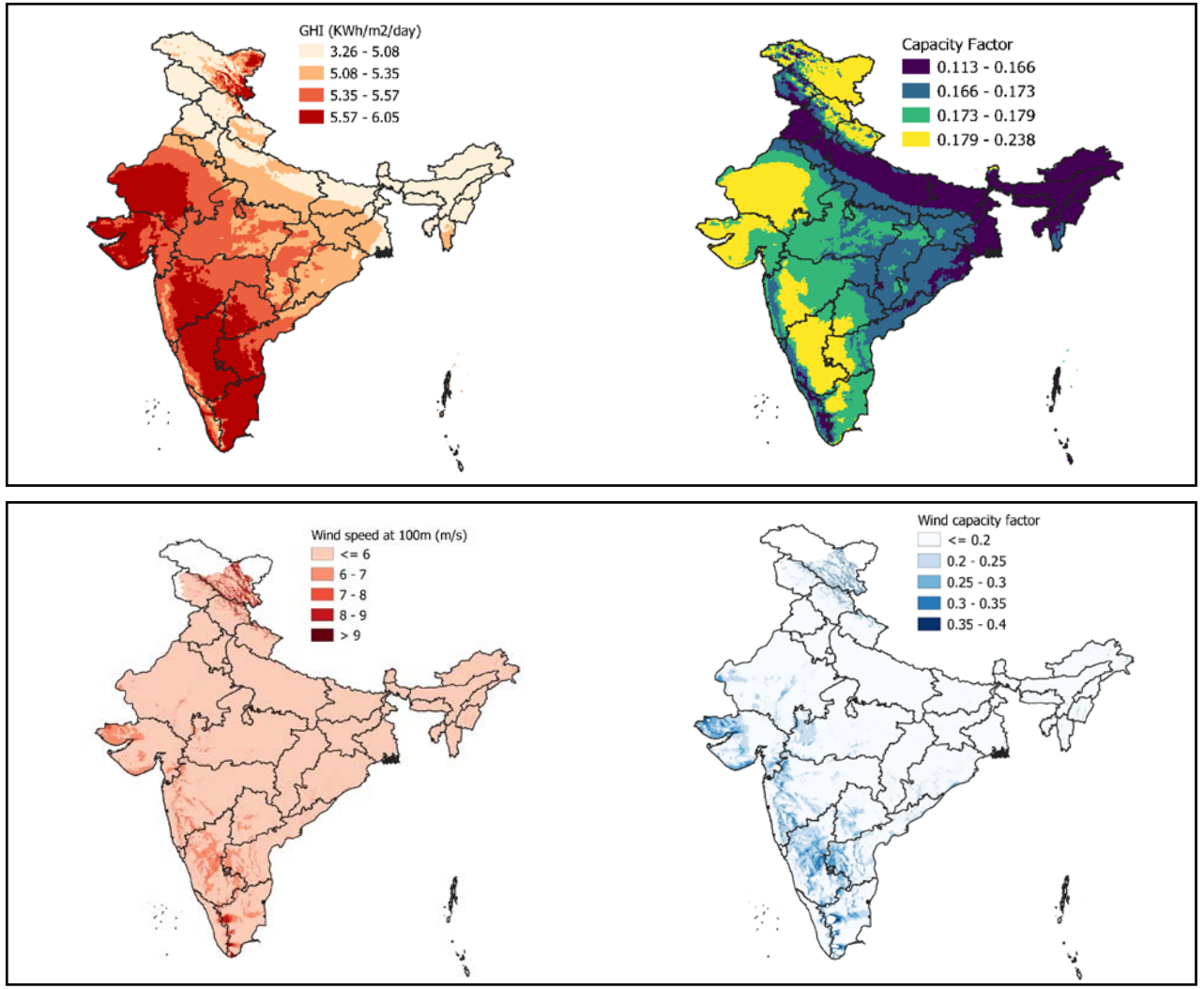

b
Wind onshore employment factors (FTE/MW)
both LP and capcosts
only capcosts
only LP
C&I
Manf
O&M
Region
CAZ
CHA
EUR
IND
JPN
LAM
MEA
NEU
OAS
REF
SSA
USA


a
NDC
Pol
Capacity (GW)
40000
30000
20000
10000
0
2015 2020 2025 2030 2035 2040 2045 2050
b
Production (EJ)
400
200
0
c
New Capacity (GW)
2000
1500
1000
500
Tech
Biomass
Coal
Gas
Geothermal
Hydro
Nuclear
Oil
Solar|CSP
Solar|PV
Wind


a
Location of coal plants and coal mines
b
Location of other power plants
c
Location of solar and wind power plants
d
Location of under−construction plants and proposed mines
Capacity (GW)
0
250
500
1000
2000
4000
Source
Biopower
Co−gen
Gas
Hydro
Nuclear
Oil
Coal
Solar
Wind

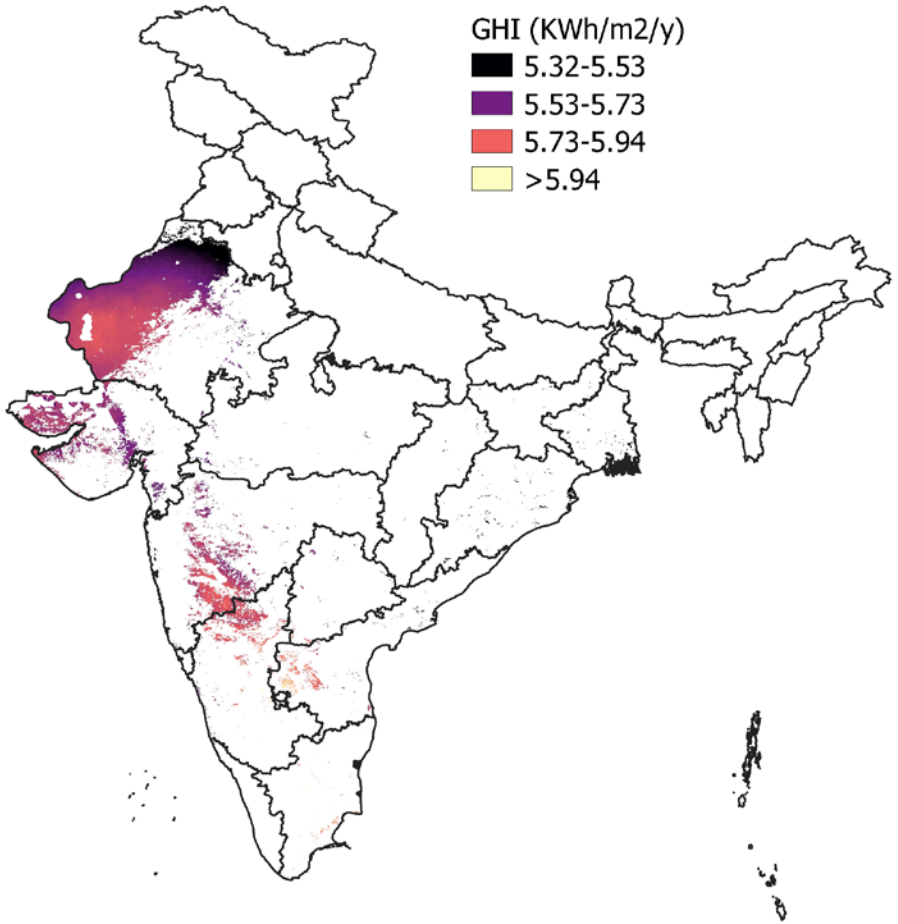
Variable	Current (2019)[1]	Source					
		CEA modelling (Central Electricity Authority, 2020a)		India Energy Outlook (IEA, 2021)		REMIND	
		2030[2]	2040	2030	2040	2030	2040
Capacity Solar (GW)	38	280	-	248-330-367	724-792-806	288-555	1015-2406
Capacity Wind (GW)	38	140	-	96-121-163	217-289-334	118-177	242-507
Capacity Coal (GW)	235	267	-	269-252-221	260-231-144	345-123	432-0
Primary Energy|Coal (EJ)	17.3	23[3]		20.9-19.4-13.3	22.7-20.8-8.8	28-10	41-1
Coal production (Mtce)	409	-	-	519-472-304	560-515-161	-	-

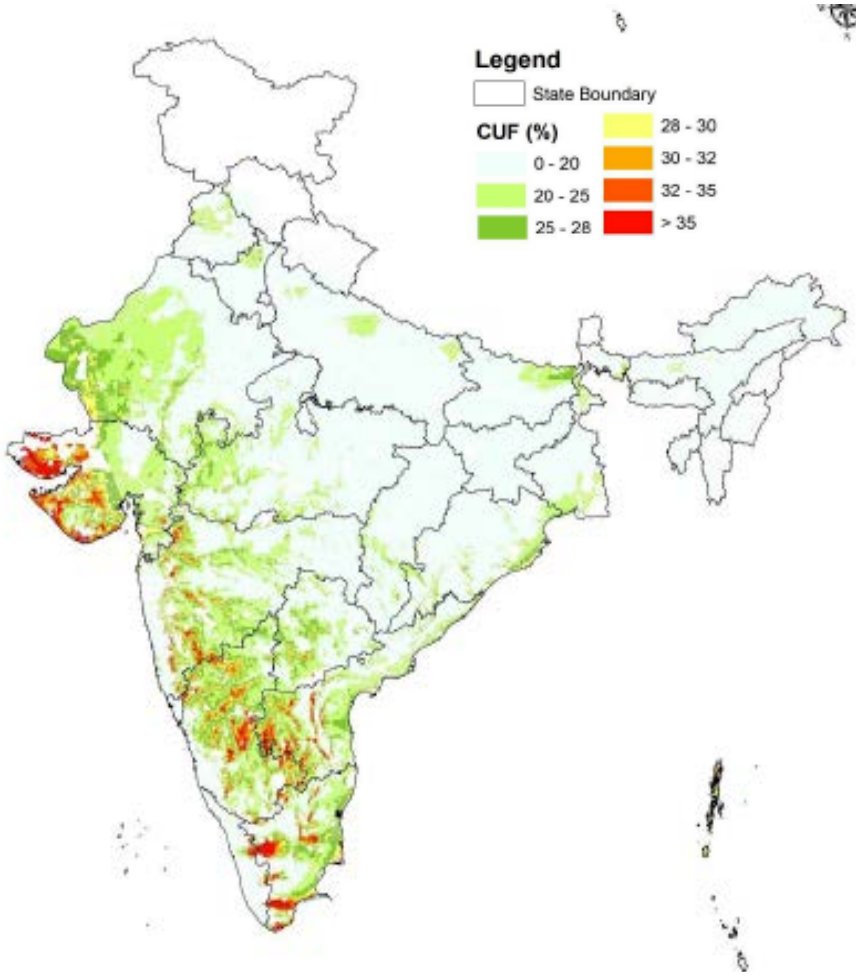
a| Most favourable solar PV areas situated in the north, west, and south; wind areas located in the south and west



Malik and Bertram, 2021 (submitted)

b| Most favourable RE potentials located in the west and south





Employment and energy transitions

- Employment is key in any policy-making, including decarbonization policies
- Country-wide or macroeconomic aspects
  - Difficult to estimate
  - Connections with many sectors; focus on **core energy sector.**
  - Energy sector employment ~1.2% of total global employment
  - 3.3 billion vs. 40 million total world direct energy jobs
  - Despite the insignificant share, core energy sector jobs are **directly linked** to energy policy, are a source of **indirect job creation** and **important revenue** for states.
- Regional aspects
  - **Just transition** - ease political opposition, broaden societal goals beyond climate, and long-term socio-economic effects.