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Potential Competition for Biomass between Biopower and Biofuel under RPS and RFS2

Presented by Lizhi Wang

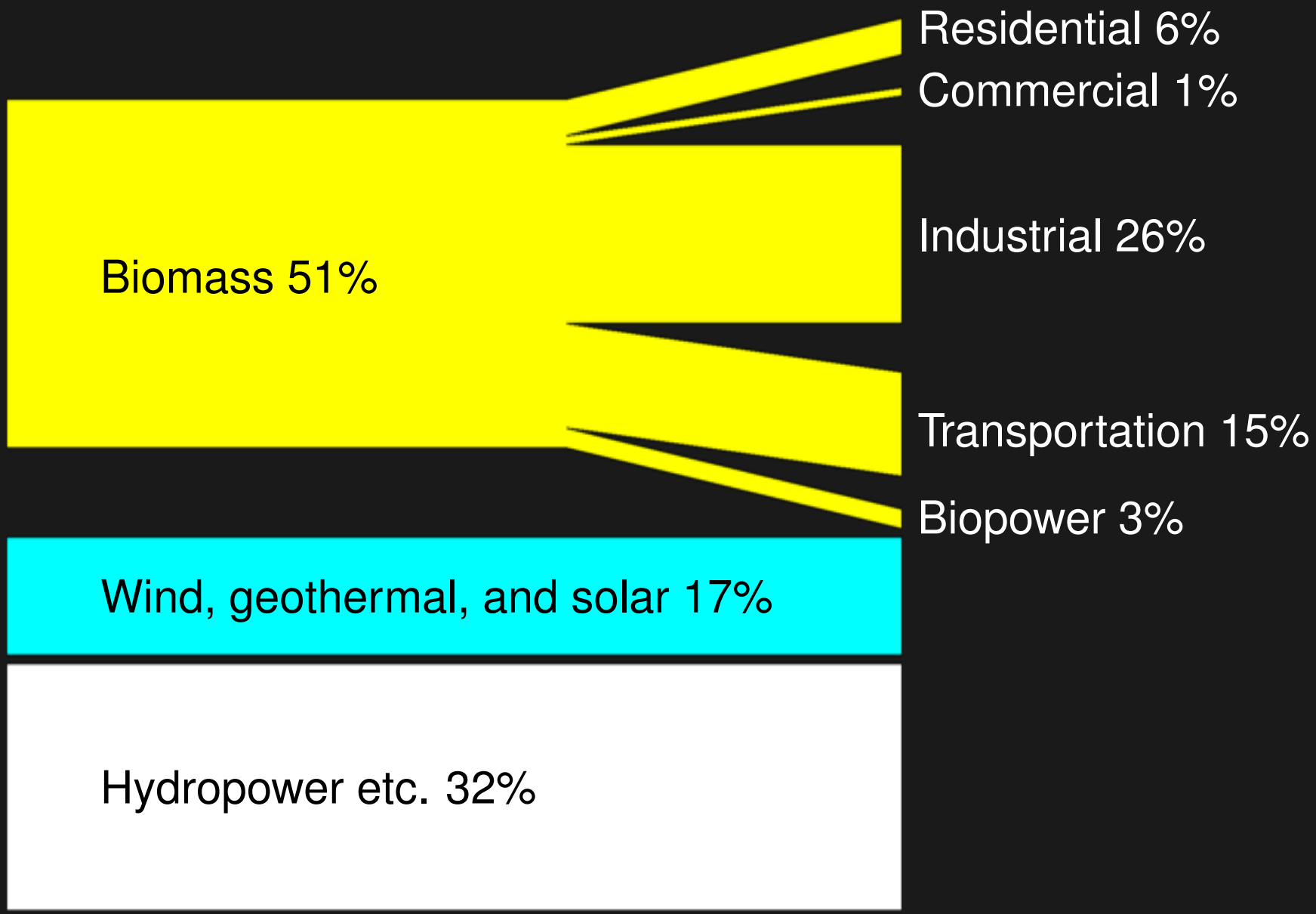
In collaboration with Mohammad Rahdar and Guiping Hu

WESEP 594
Iowa State University

January 22, 2014

Outline

Renewable energy portfolio in the U.S. in 2011



Policy drivers

RPS

- Renewable portfolio standard (RPS) is a state-level regulation that requires the increased generation of renewable electricity
- 30 states have established mandates and 8 have goals

RFS2

- 2005 Renewable fuel standard (RFS): 7.5 billion gallons of renewable fuel by 2012
- 2007 revision (RFS2): 36 billion gallons by 2022, including 16 billion gallons for cellulosic and 20 billion gallons for non-cellulosic

Tax credits

- Production tax credit
- Investment tax credit

Five research questions

Q1: Interactions between RPS and RFS2?

Q2: Competition for biomass in the next two decades?

Q3: U.S. renewable energy portfolio outlook?

Q4: State level outlook?

Q5: Sensitivity analysis?

Related literature

RPS

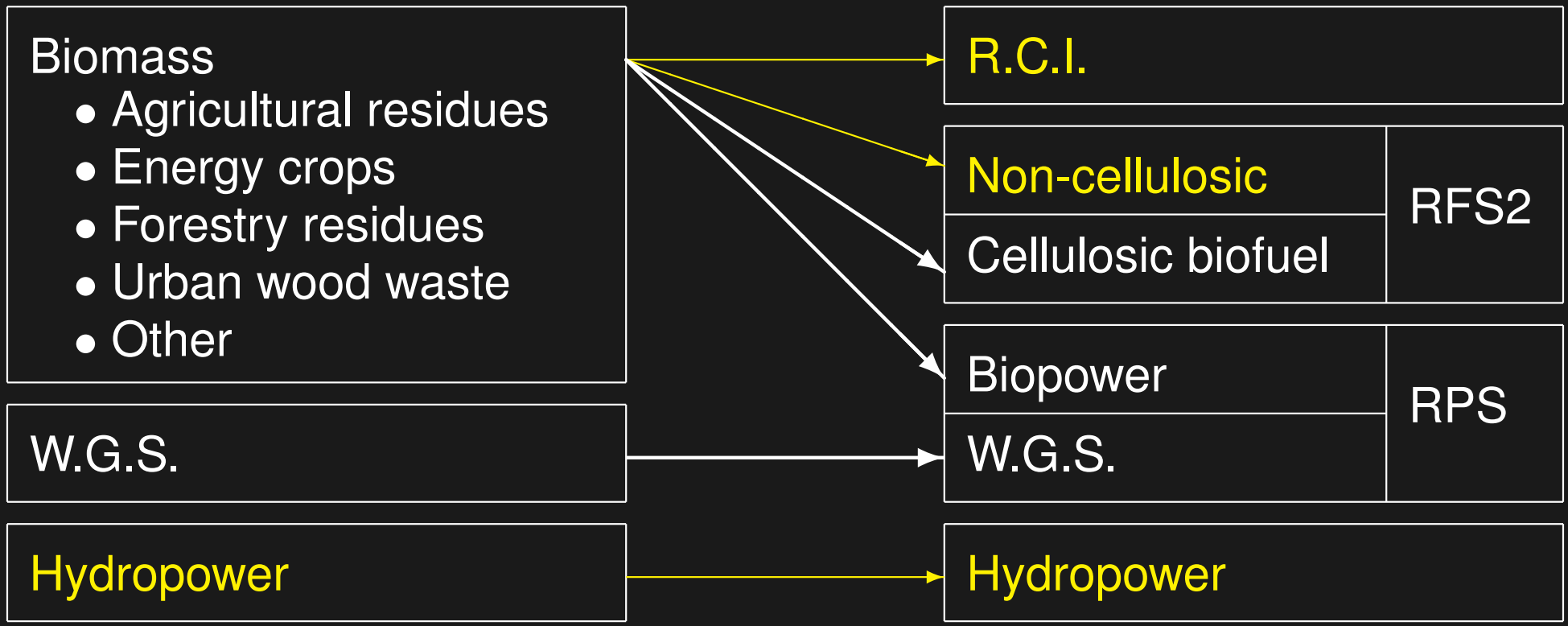
- Johnson and Moyer (2012)
- Carley (2009)
- Yin and Powers (2010)
- Menz and Vachon (2006)

RFS2

- Jeffers et al. (2013)
- Huang et al. (2013)

Outline

Supply and demand



Features

- All major renewable energy resources (biomass, W.G.S., and hydro)
- All major demand sectors (biopower, non-cellulosic and cellulosic biofuel, W.G.S. power, and hydropower)
- All 50 states and Washington D.C.
- A 23-year modeling horizon from 2013 to 2035

Assumptions

- Centralized and coordinative planning perspective
- Deterministic model with sensitivity analysis
- Several factors treated as known parameters
- Hydropower treated as RPS ineligible

Centralized optimization model

- Objective
  - Maximize system-wide profit (revenues minus production costs, investment costs, and non-compliance penalties)
- Decision variables (261,603)
  - Wind, geothermal, solar, biopower generation
  - Cellulosic biofuel production
  - Biomass production and transportation
  - New capacity investment
  - RPS and RFS2 shortfall
- Constraints (22,380)
  - Biomass resource constraints
  - Yearly renewable energy generation and biofuel production capacity updates
  - Limits on new capacity investment
  - RPS and RFS2 requirements

Outline

Q1: Interactions between RPS and RFS2?

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	Case 1	Case 2	Case 3	Case 4
RPS or RFS2 Policy	Neither	RPS	RFS2	Both
W.G.S. (B kWh/year)	320.68	385.87	320.68	386.01
Biopower (B kWh/year)	0.17	26.01	0.17	16.78
Biomass (M ton/year)	0.14	21.68	0.14	13.98
Cellulosic biofuel (B gallon/year)	0.02	0.02	7.71	7.41
Biomass (M ton/year)	0.32	0.32	128.54	123.53

- RFS2 has more influence than RPS on biomass pathways.
- RFS2 has little impact on WGS generation.

Q2: Competition for biomass in the next two decades?

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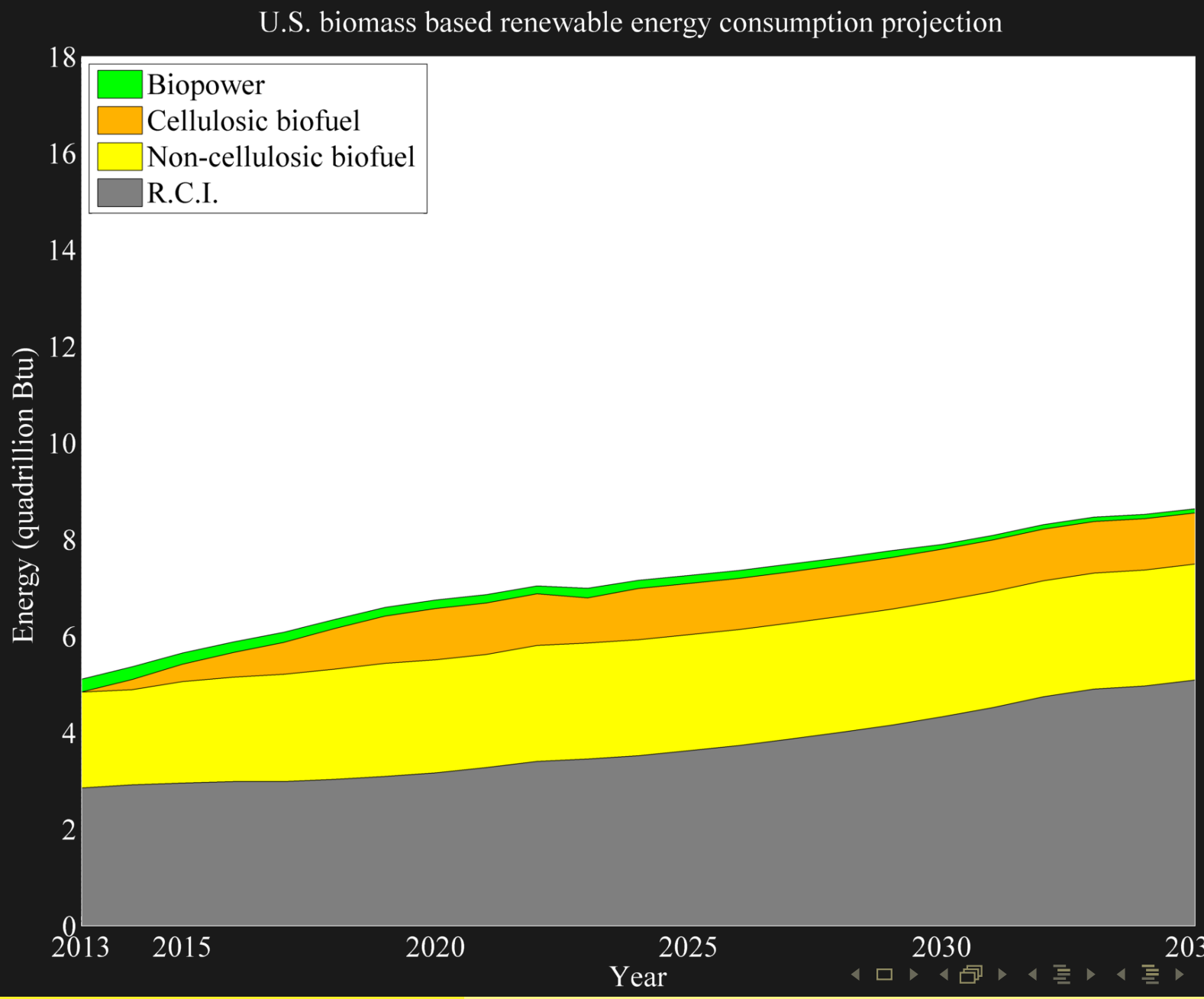

Q3: U.S. renewable energy portfolio outlook?

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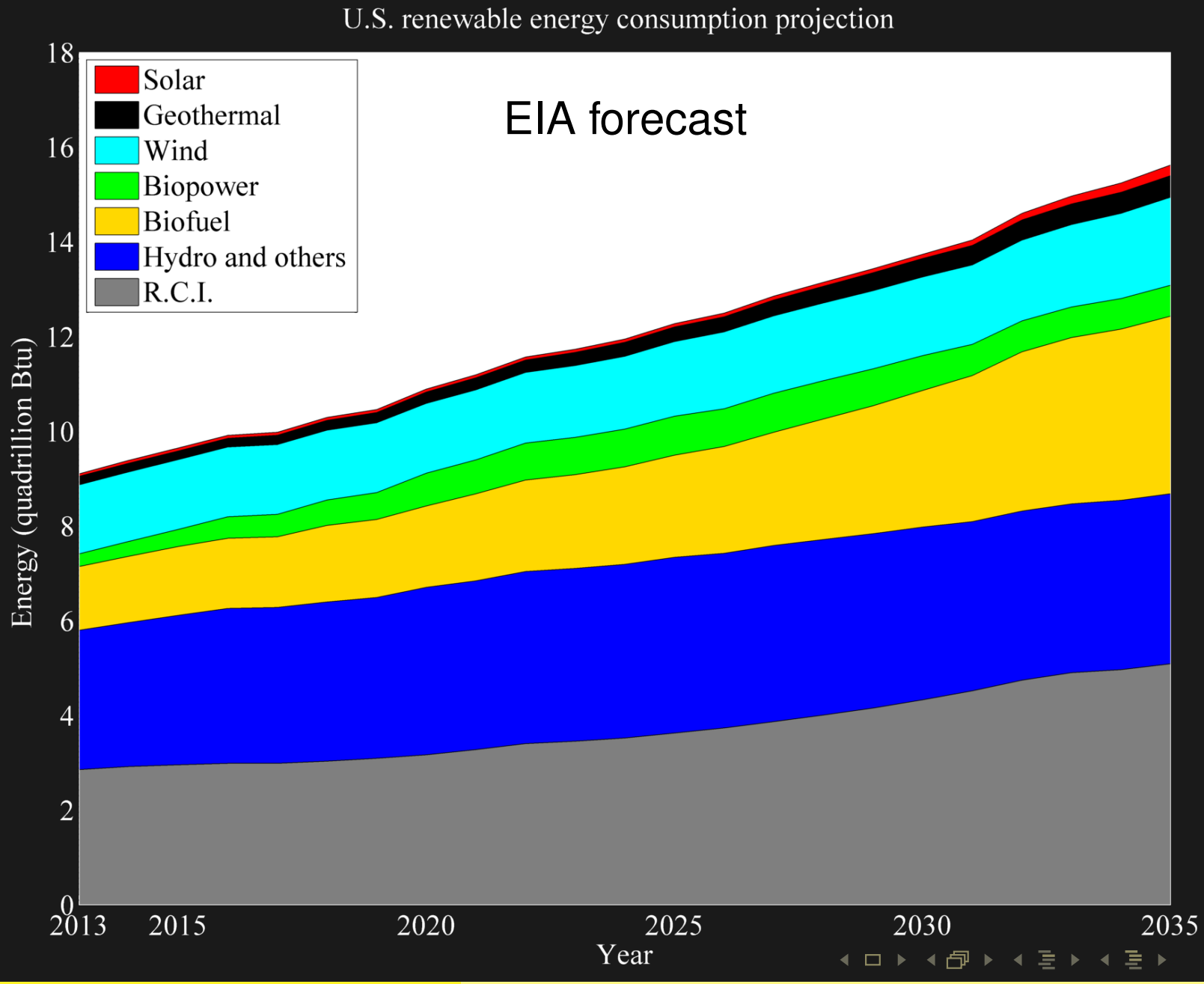

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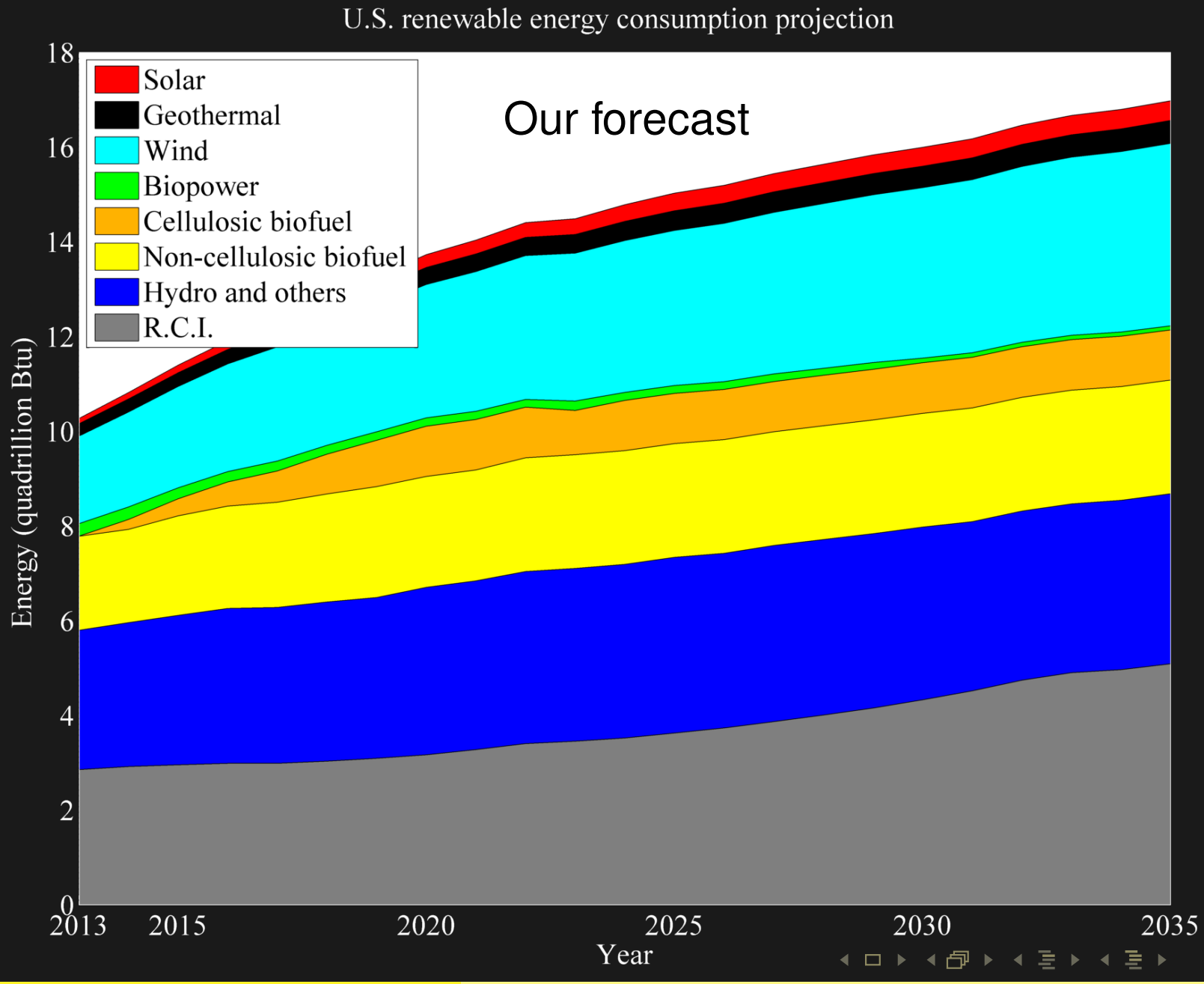

Q4: State level outlook?

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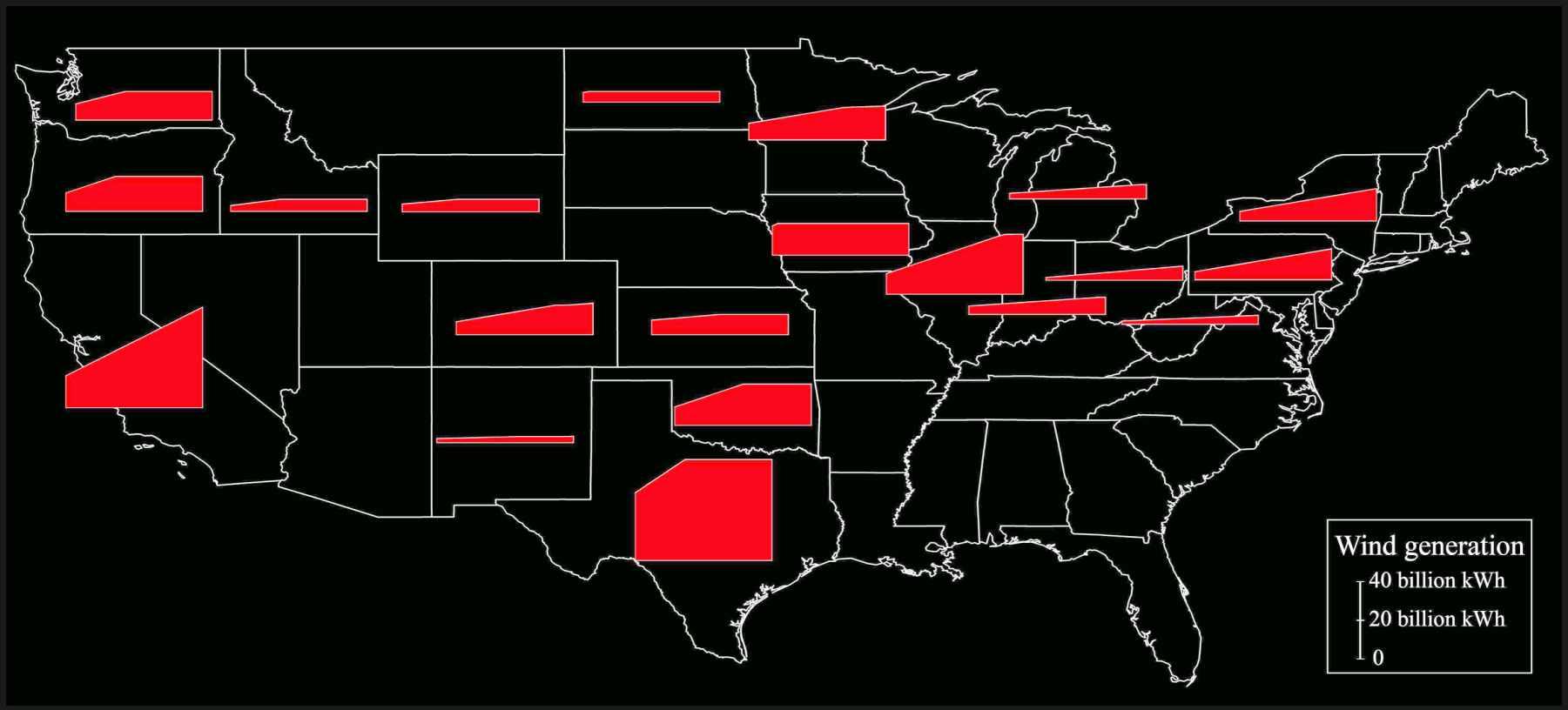
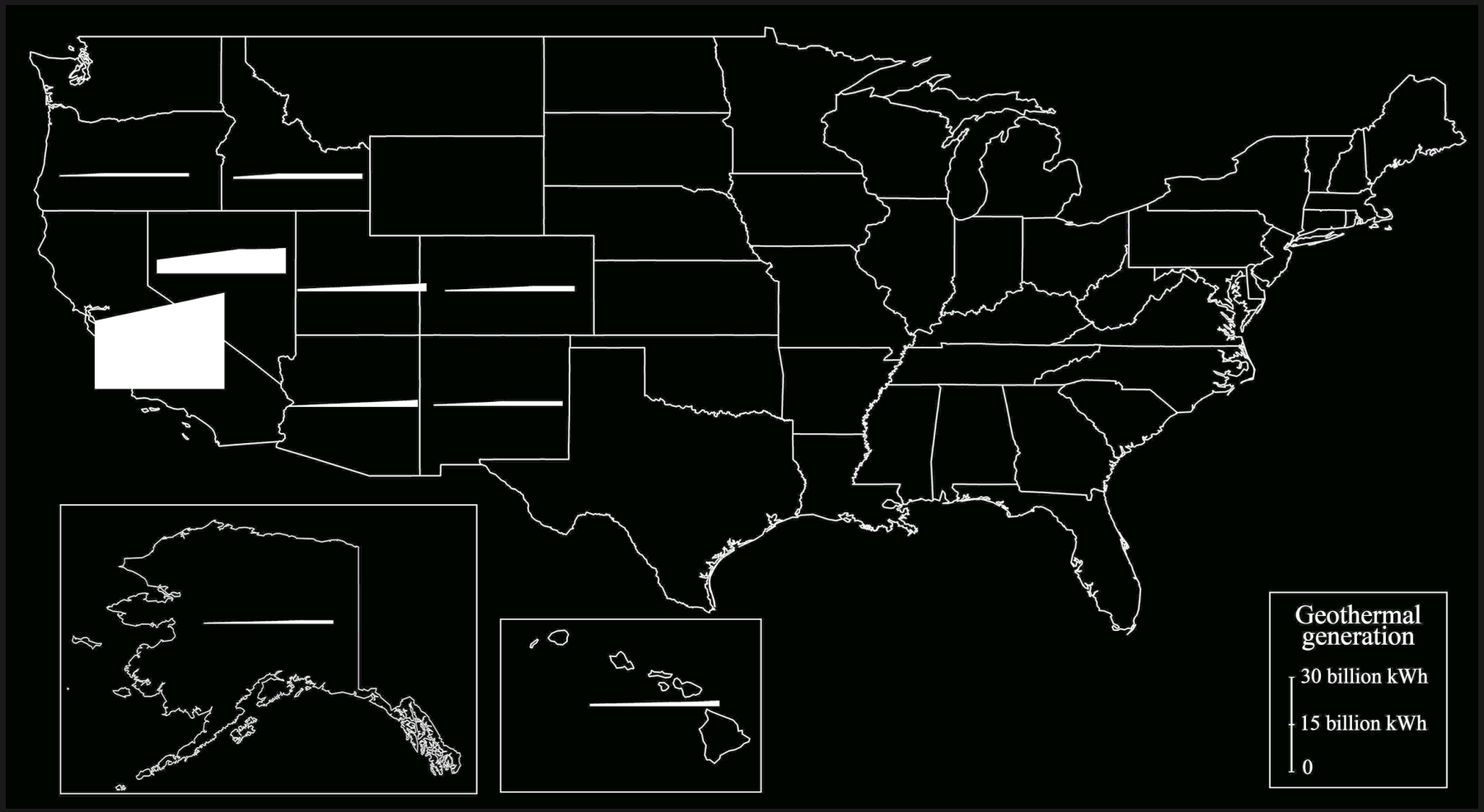


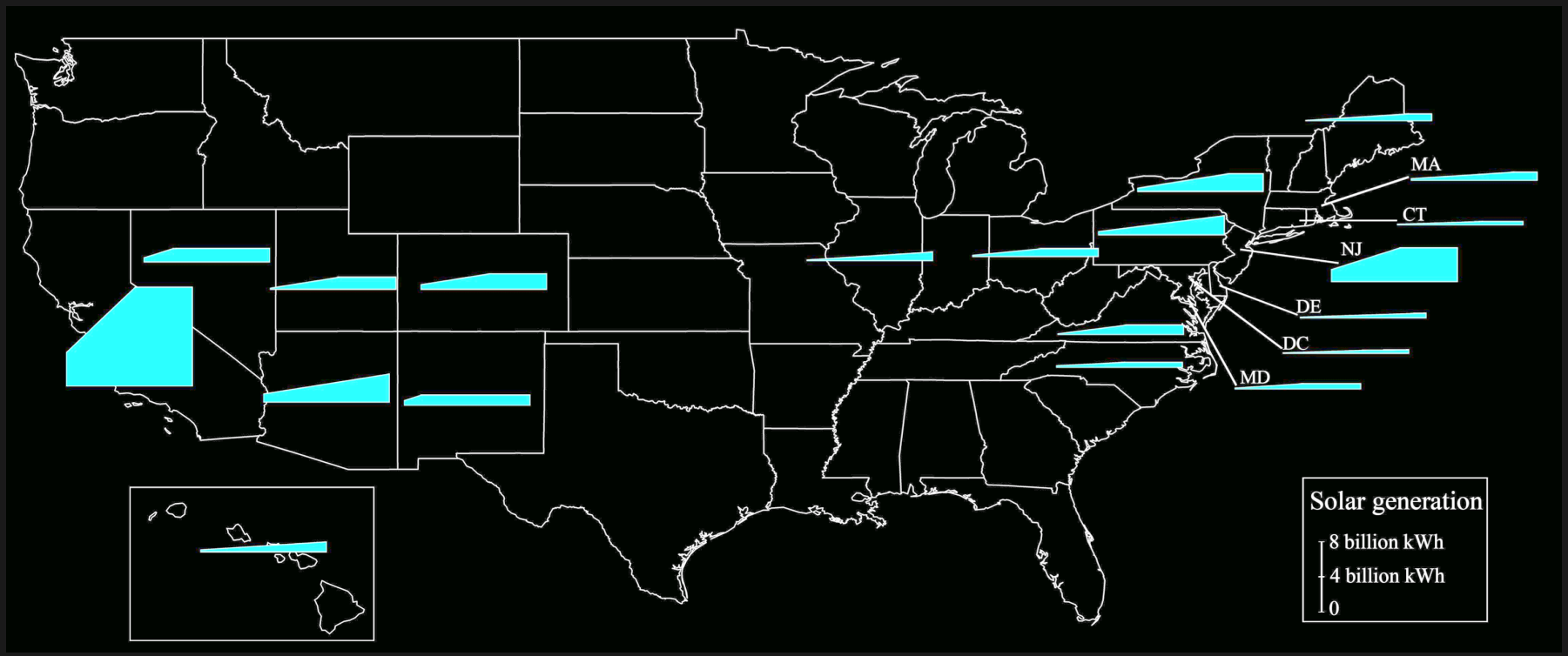
wind

Q4: State level outlook?



geothermal

Q4: State level outlook?



solar

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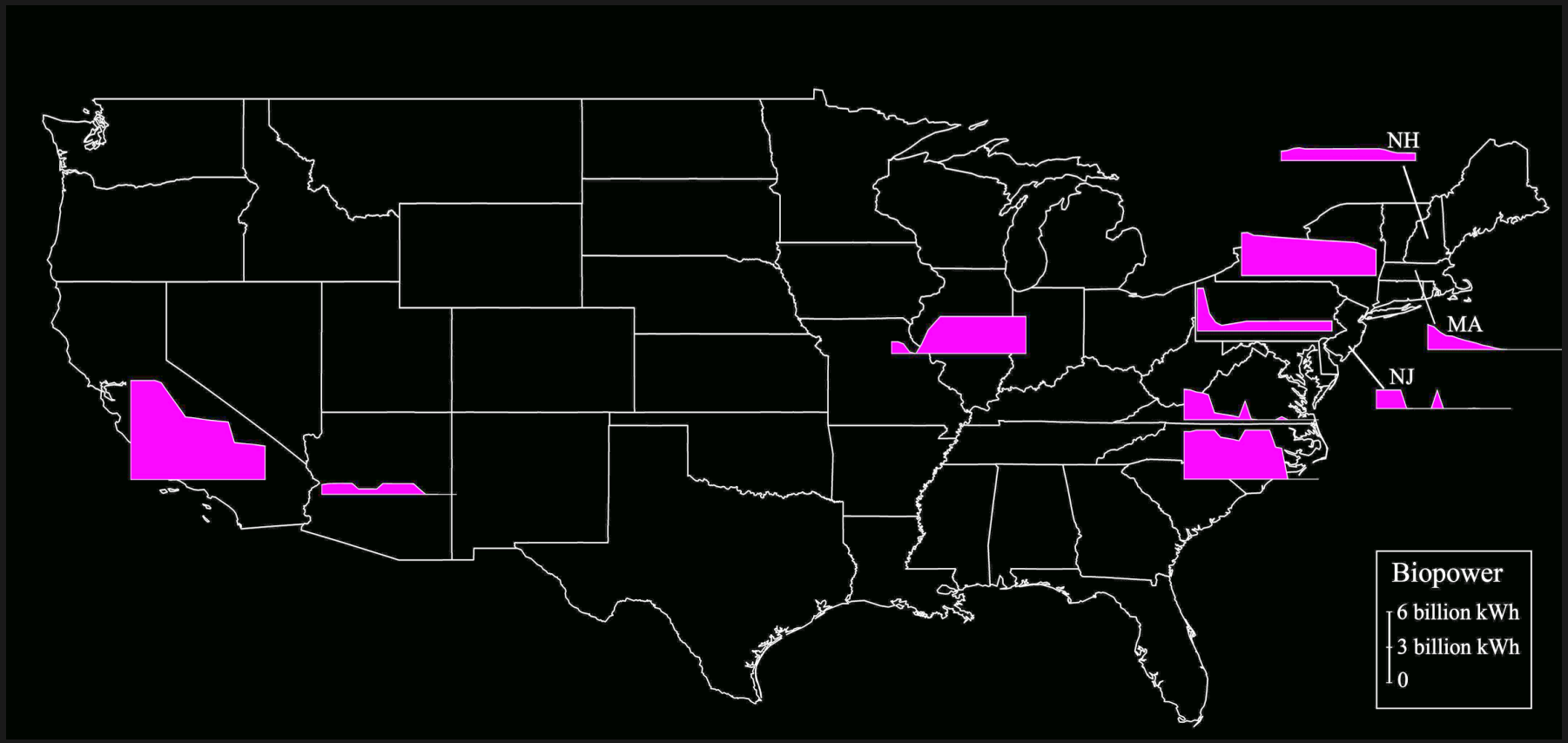
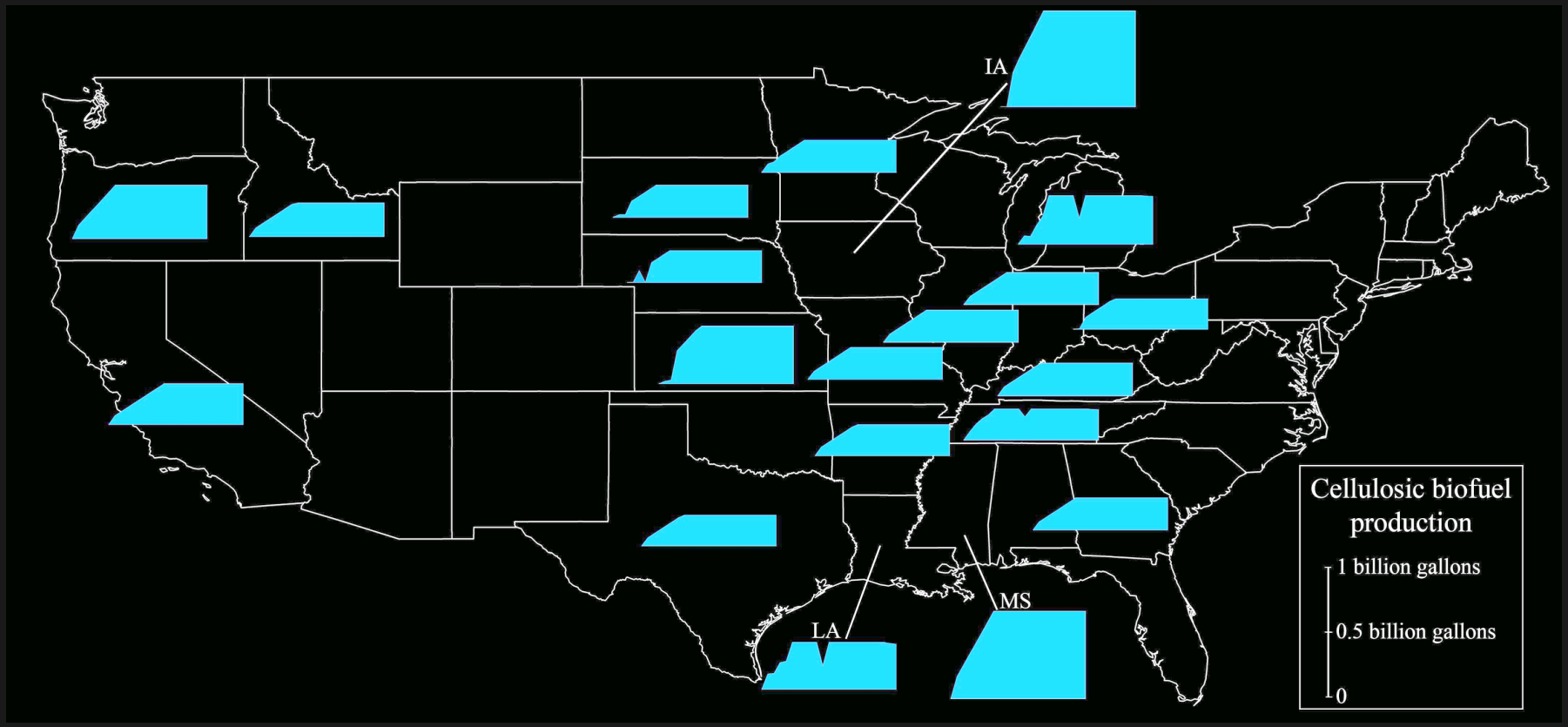


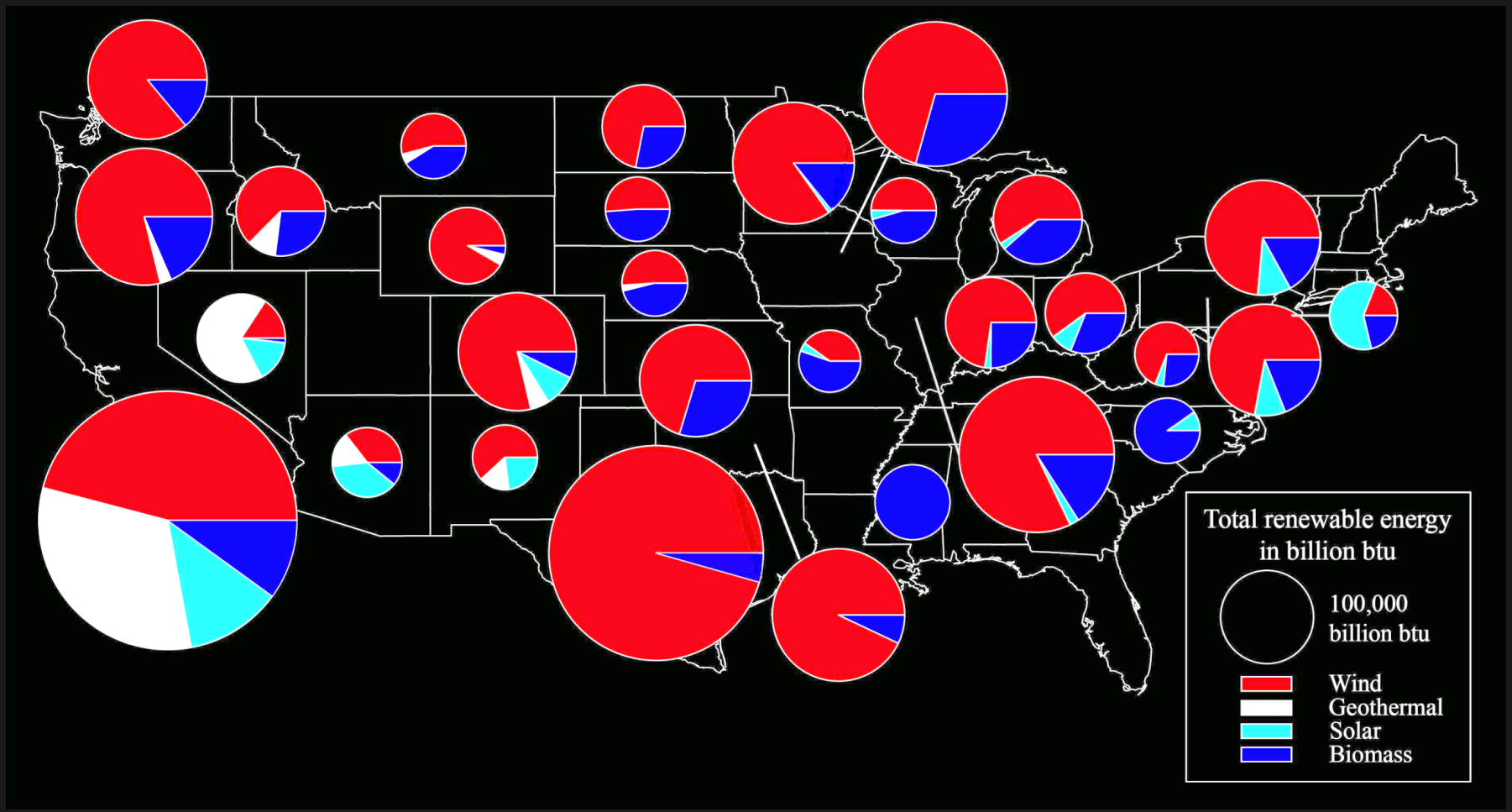
biopower

Q4: State level outlook?



cellulosic biofuel

Q4: State level outlook?



portfolio

Q5: Sensitivity analysis?

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	Optimistic	Pessimistic
Cost parameters	-20%	$+20\%$
Revenue parameters	$+20\%$	-20%
Investment limits	$+20\%$	-20%
Penalty parameters	$+50\%$	-50%
Expiration dates of tax credits	2035	PTC for electricity: 2023 ITC for electricity: 2016 PTC for biofuel: 2013 ITC for biofuel: 2013

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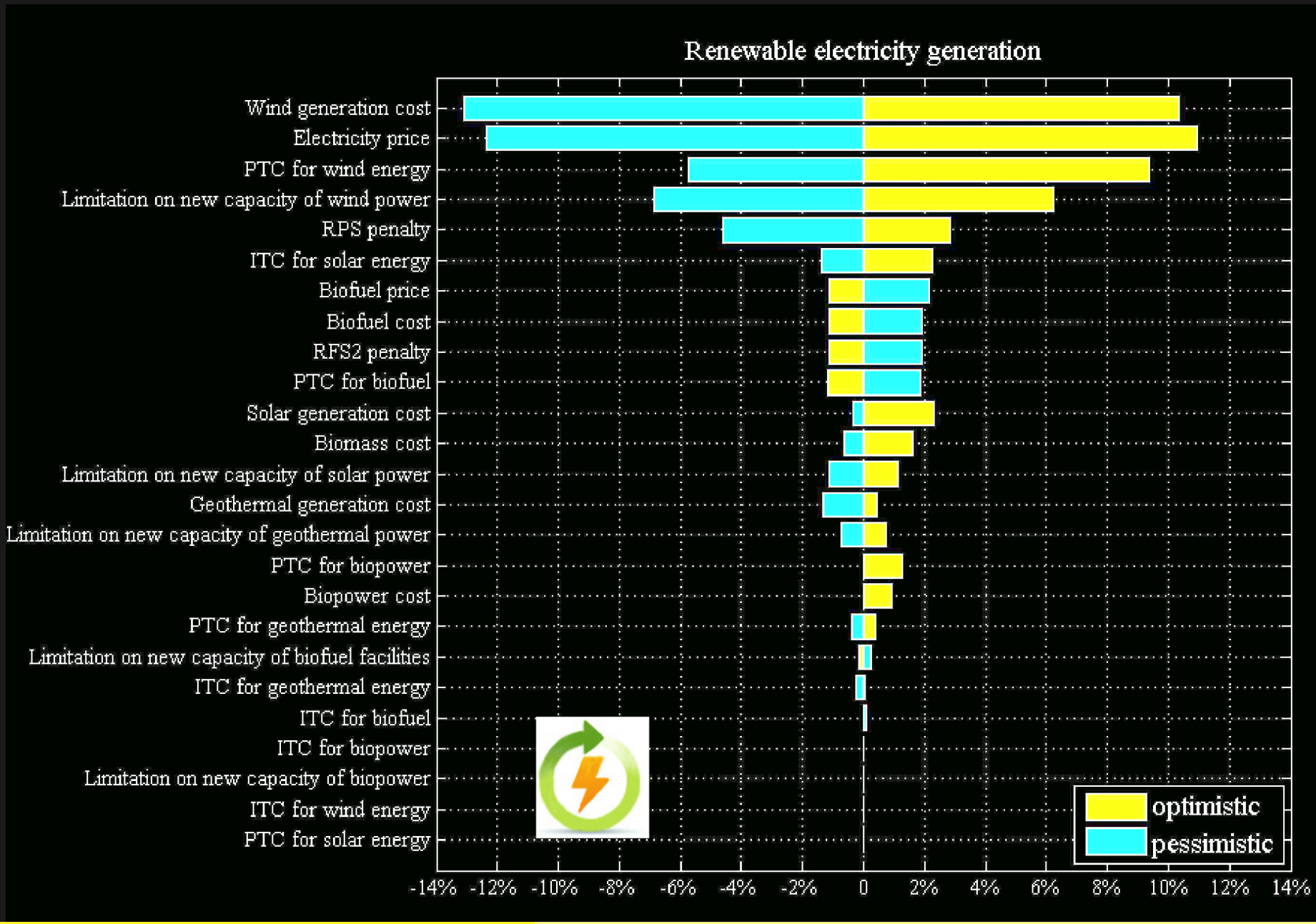

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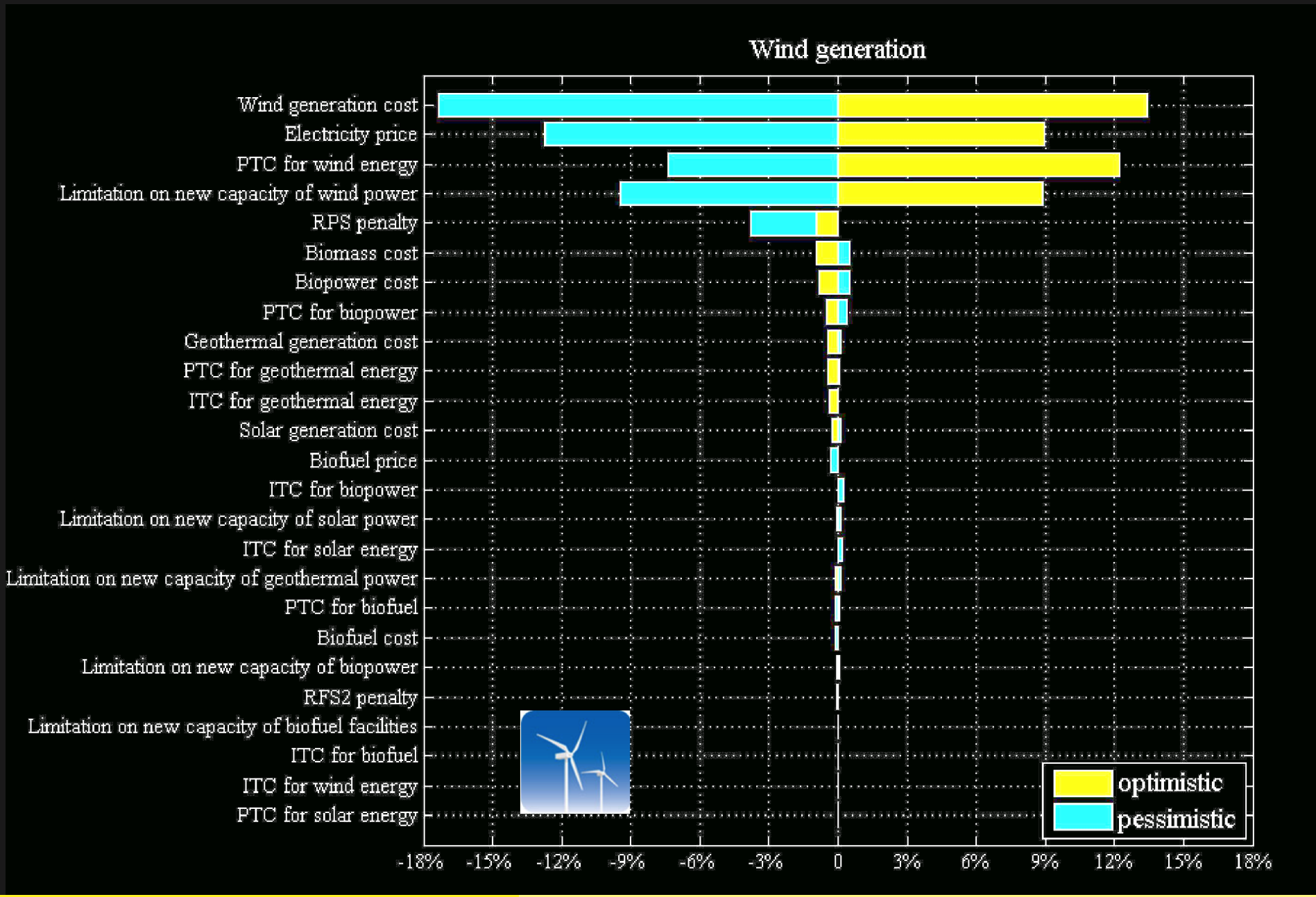

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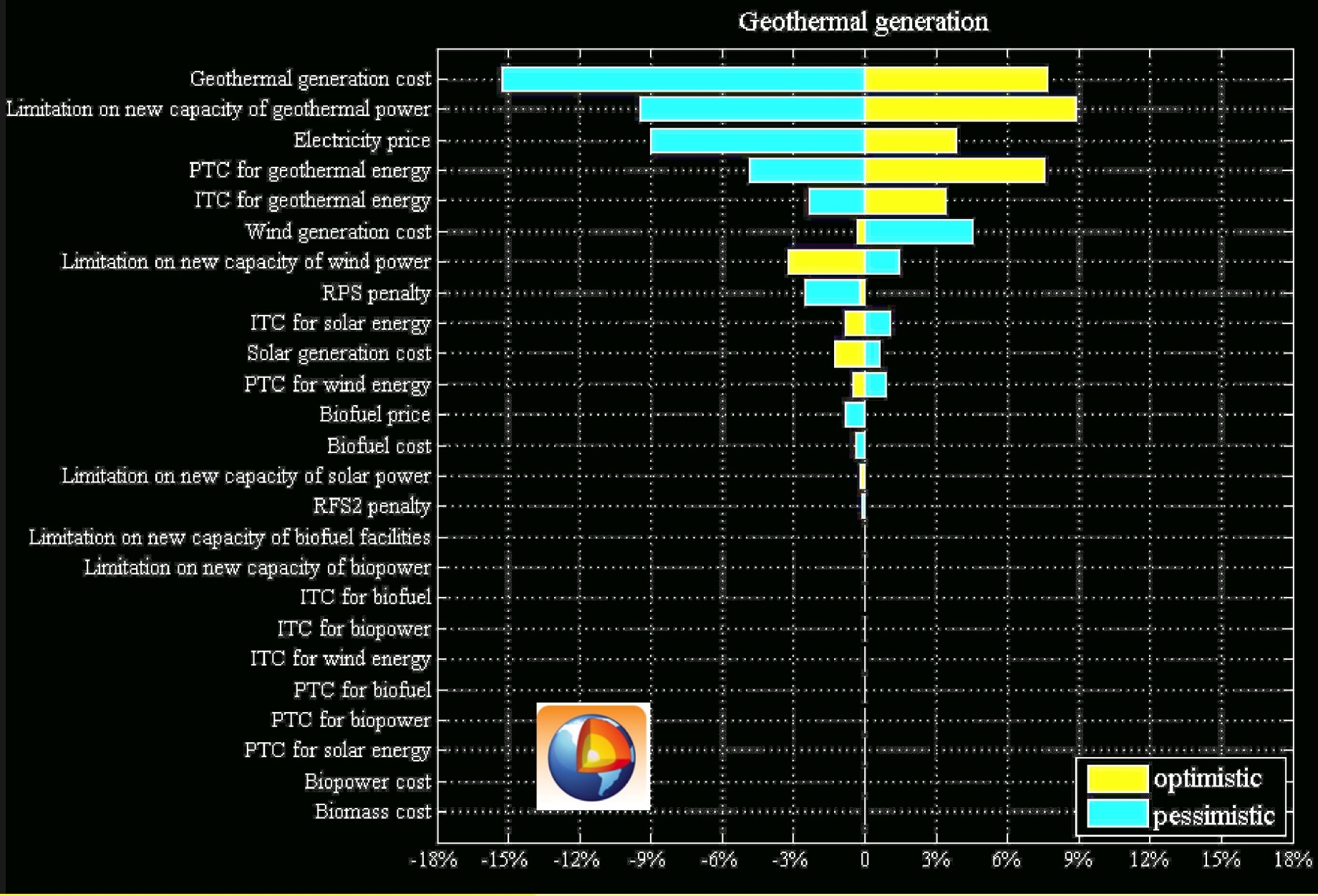

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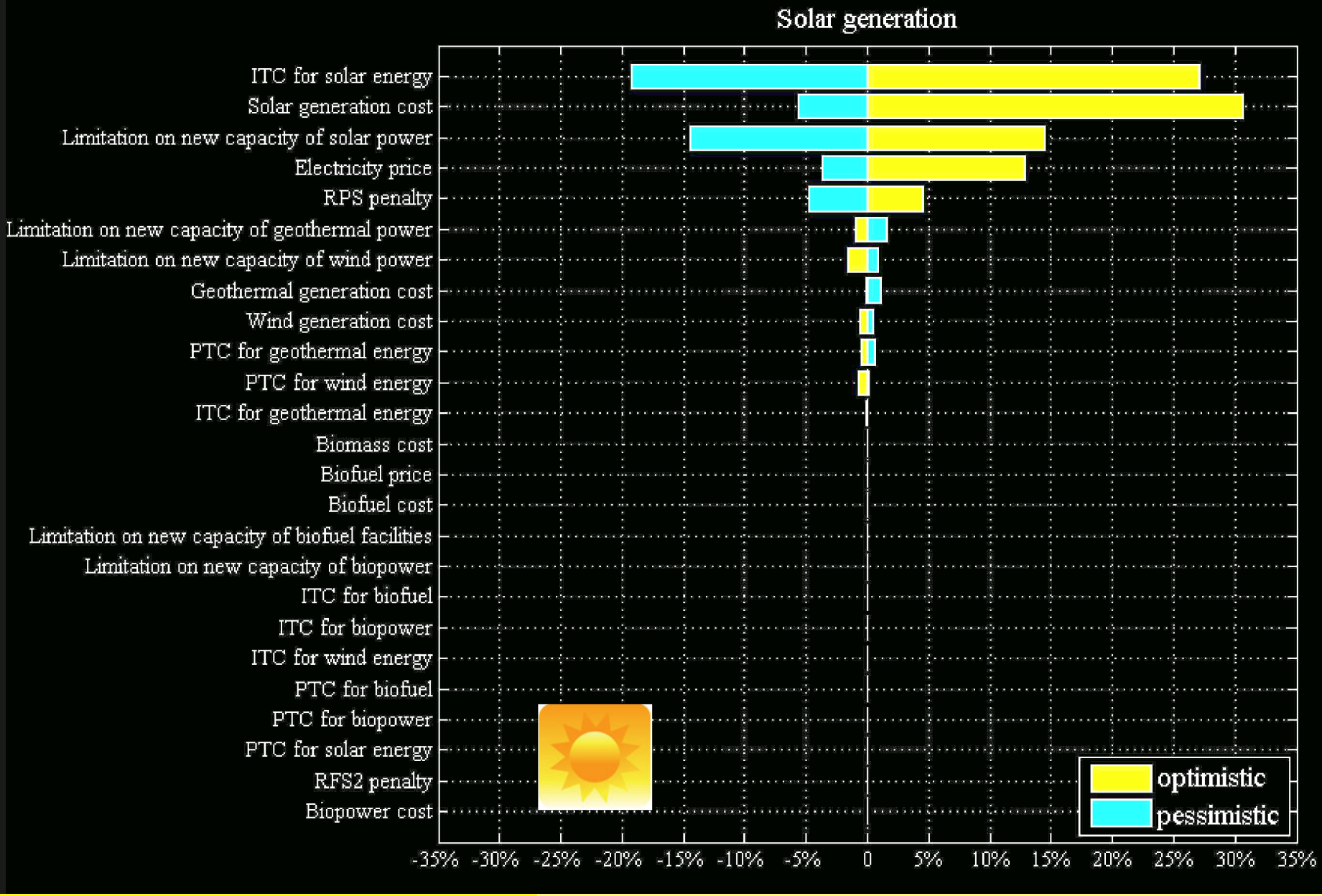

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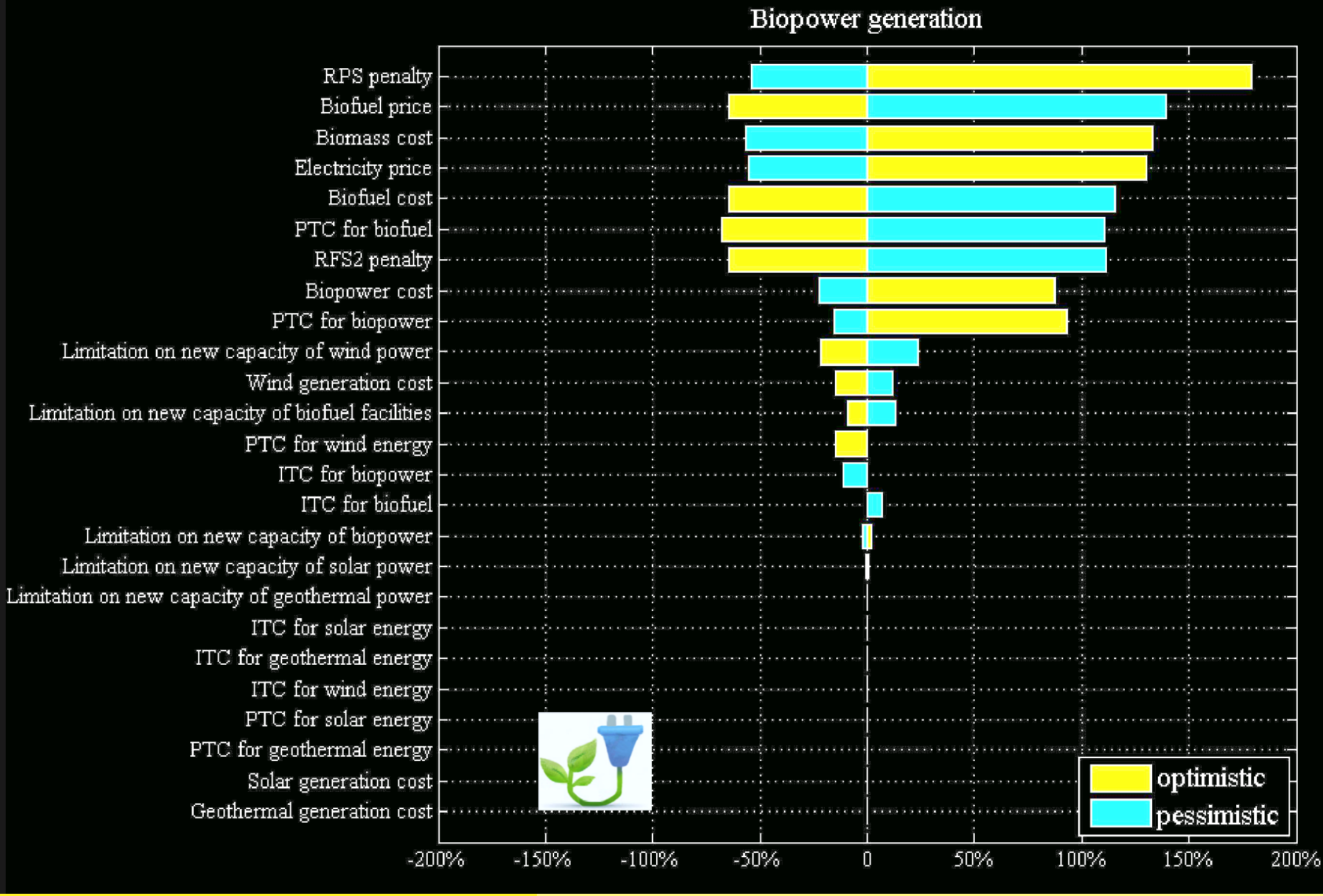

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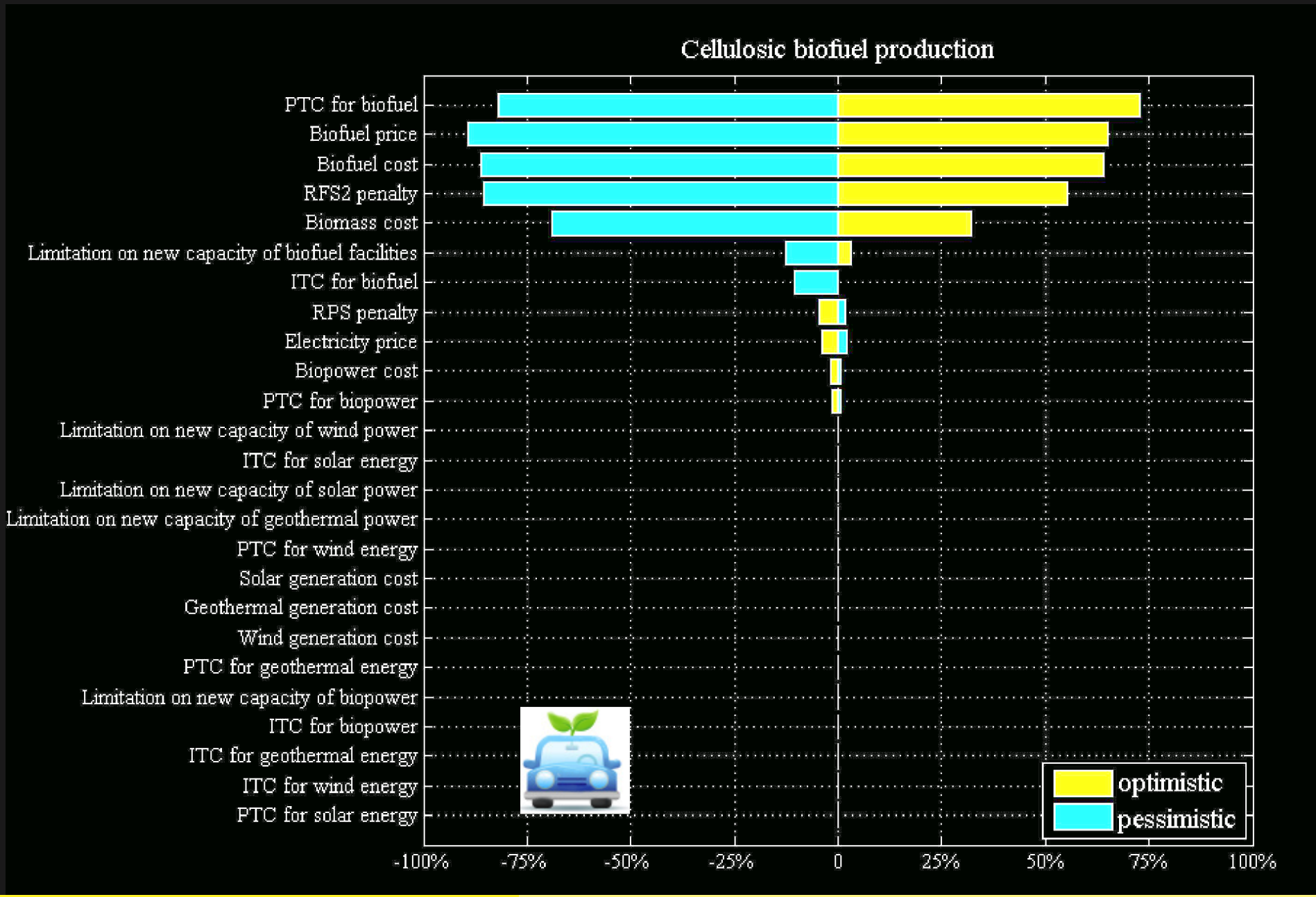

Conclusions

- Cellulosic biofuel production will quickly dominate the competition for biomass against biopower generation.
- The renewable energy portfolios in 50 states and Washington D.C. could vary significantly, and they all have their unique trajectories throughout 2035.
- W.G.S. power generation is relatively robust with respect to various uncertain factors, whereas biopower and biofuel are much more susceptible to uncertainty associated with costs, prices, and policies.