



# The Impact of Utility Tariff Evolution on Behind-the-Meter PV Adoption

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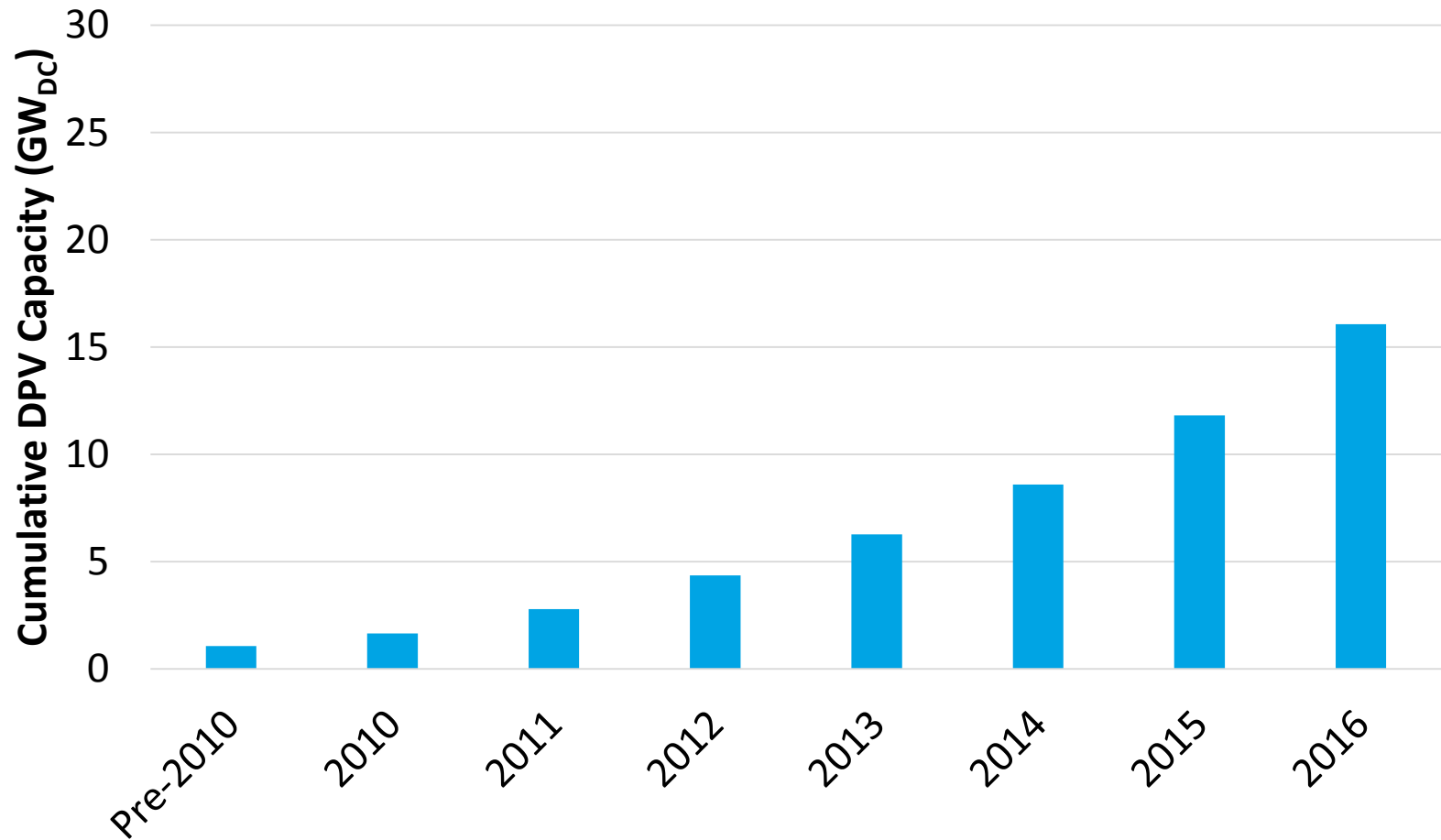
Energy Policy Research Conference

Park City, Utah

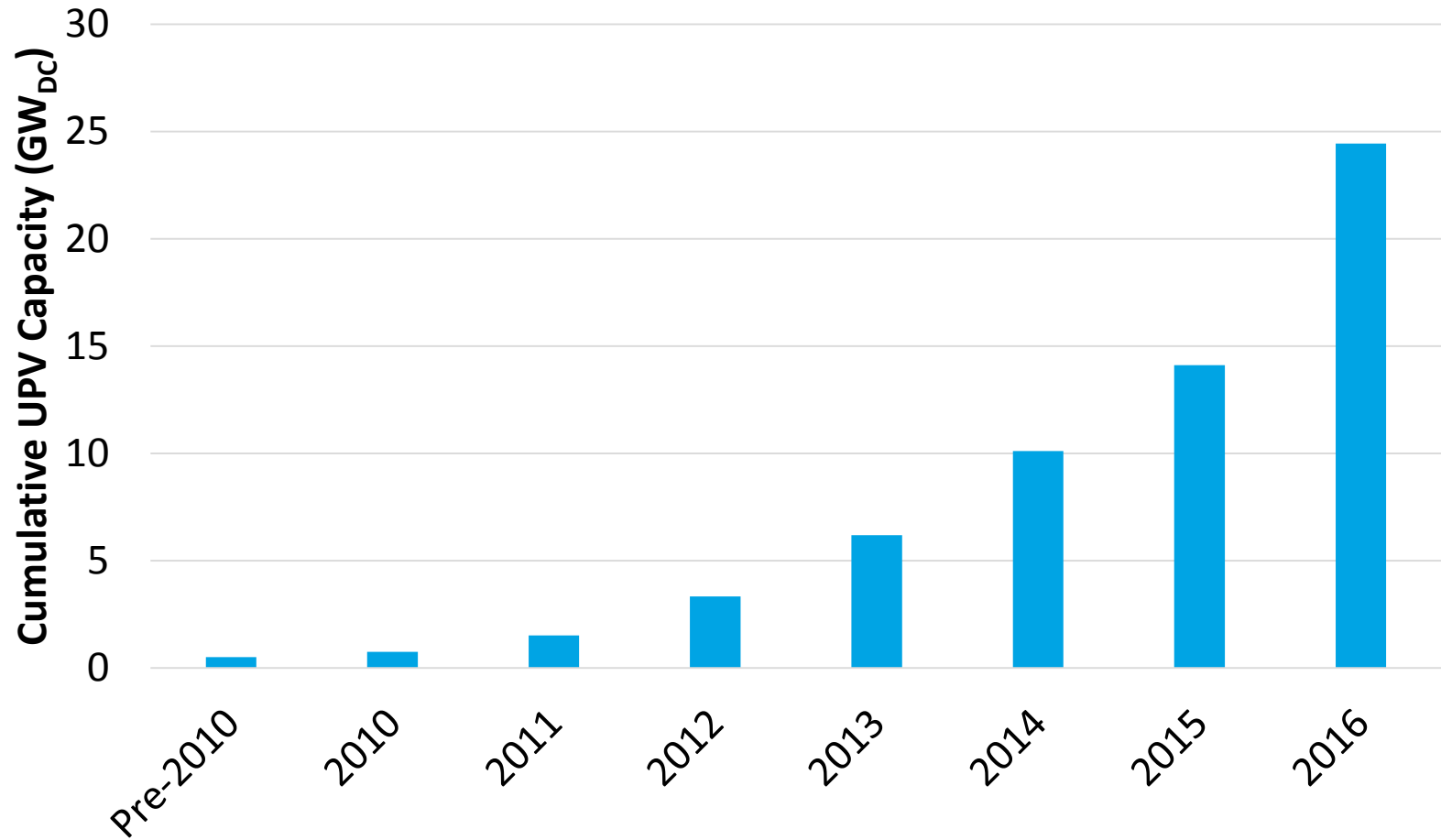
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# DPV Has Been Growing Rapidly



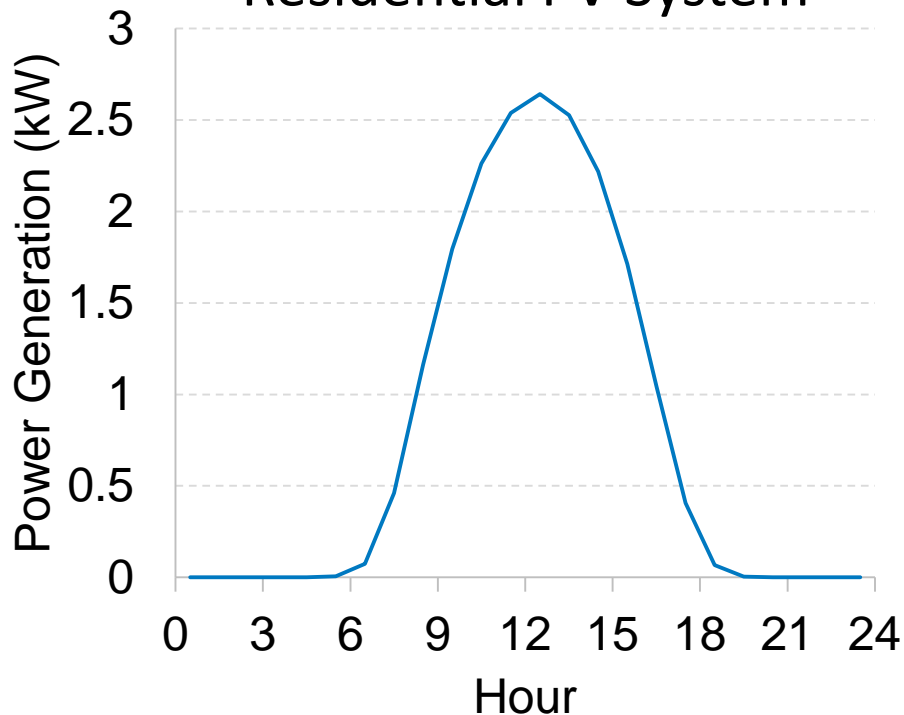
# UPV Has Also Been Growing Rapidly



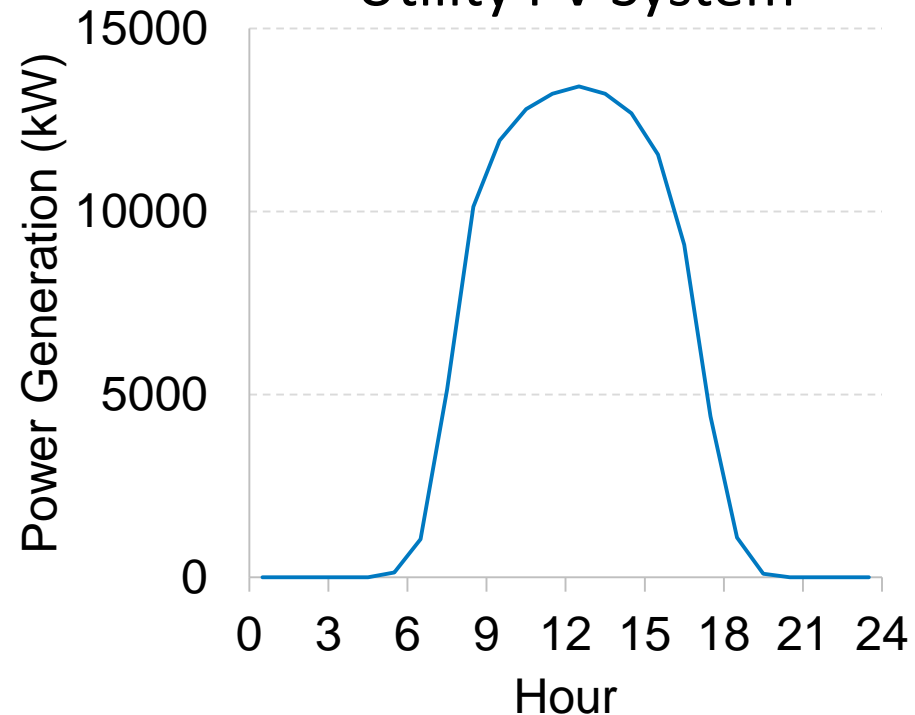
# Surprise: DPV and UPV Produce at the Same Time!

- PV systems have similar profiles – differences are due to orientation, tracking, shading, etc.

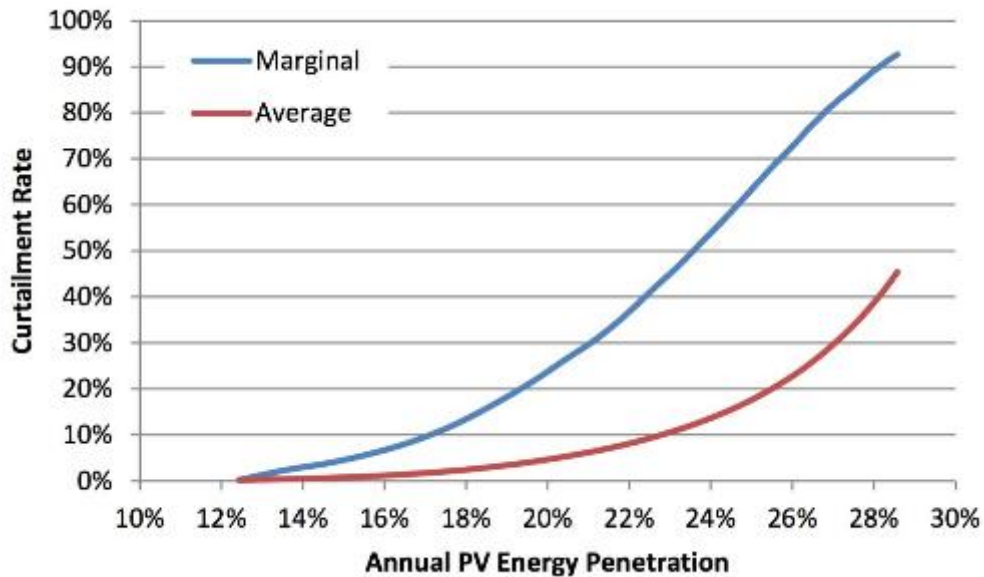
## Residential PV System



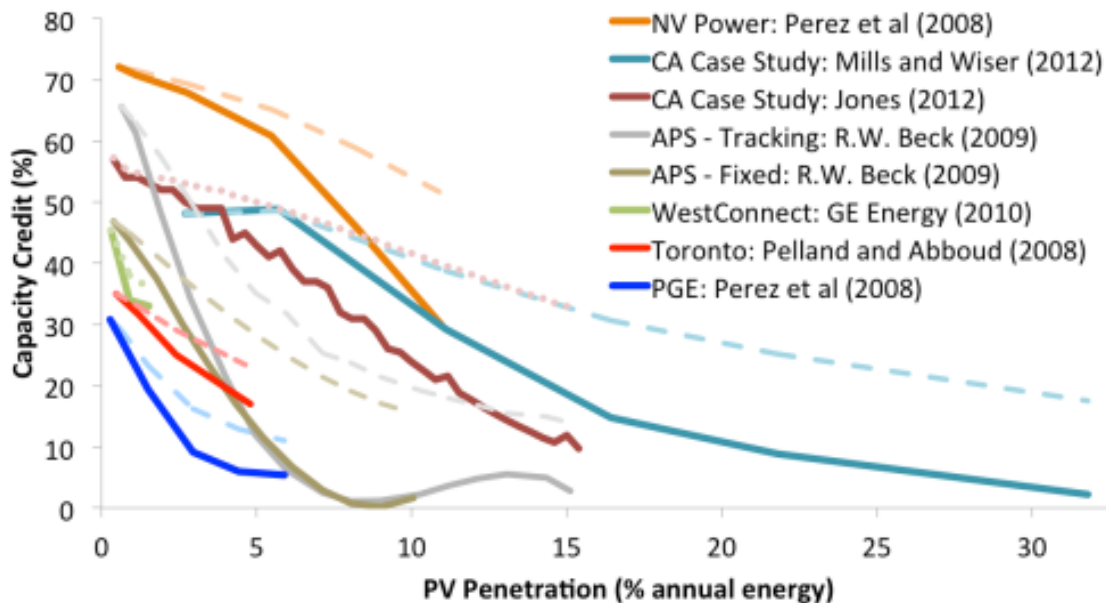
## Utility PV System



# Value of Incremental PV Declines as Penetration Increases



- Increasing curtailment rate reduces energy value
- Declining capacity credit reduces capacity value

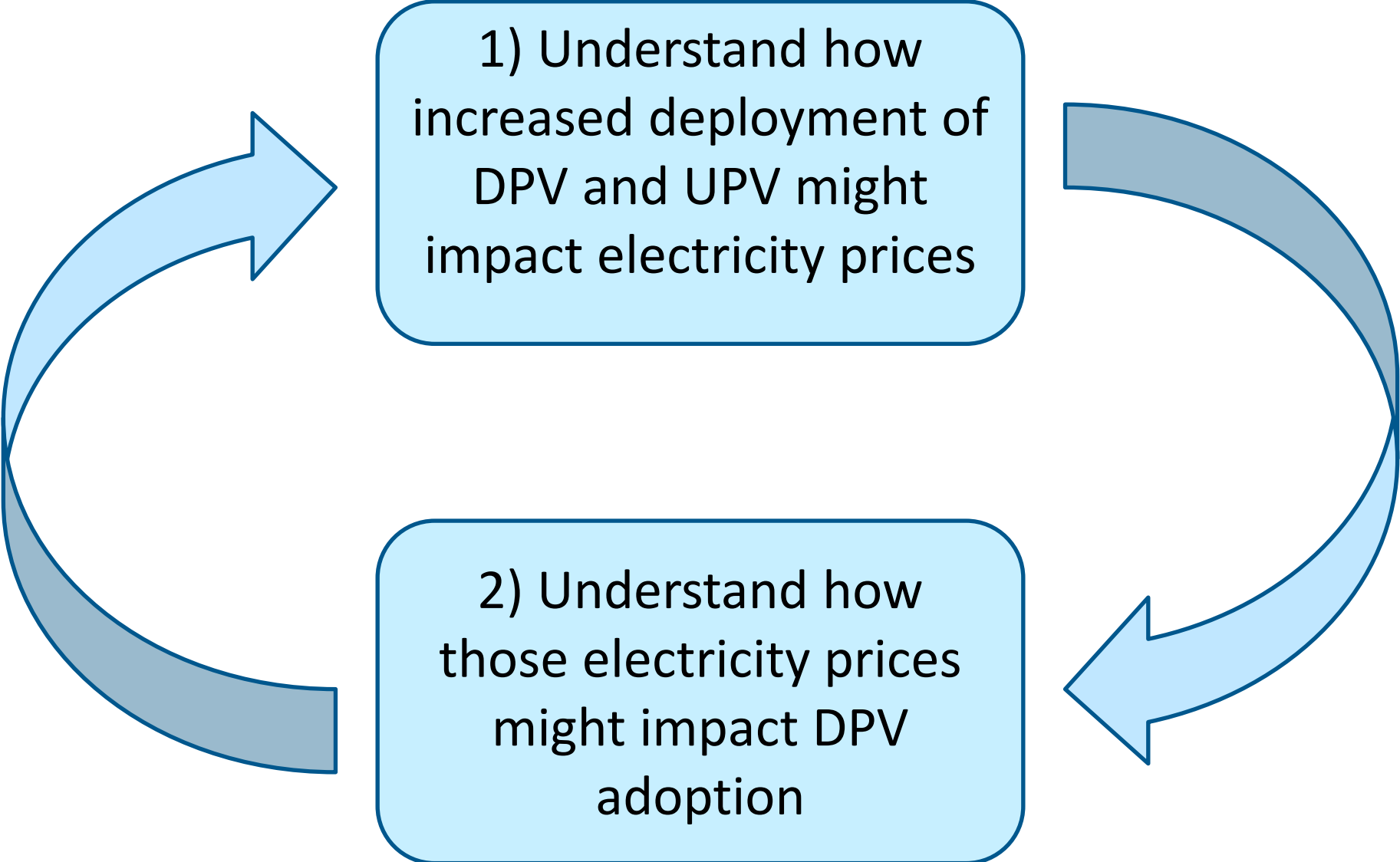


Top: Denholm & Margolis (2016)  
Bottom: Mills & Wiser (2012)

# Deployment Drivers

- UPV – Relative economics versus other utility-scale generator options
- DPV – Relative economics versus tariffs
- Both are influenced by policy (tax credits, renewable portfolio standards, etc.)

# Two Purposes of this Analysis

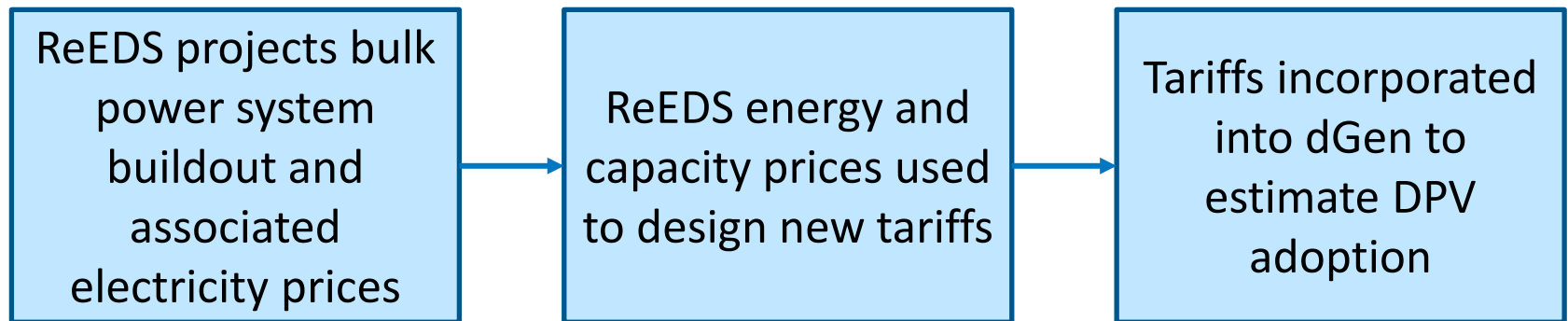


1) Understand how increased deployment of DPV and UPV might impact electricity prices

2) Understand how those electricity prices might impact DPV adoption

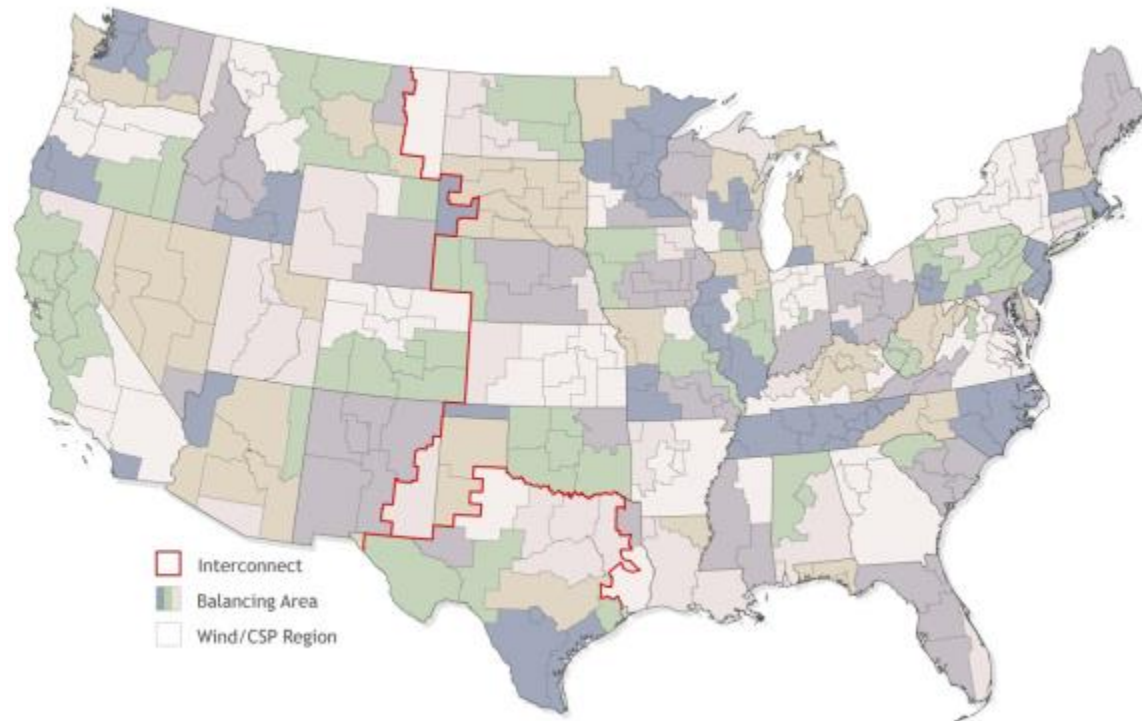
# Our Approach

- ReEDS: Bulk power system capacity expansion model for UPV deployment (and the rest of the power sector)
- dGen: Consumer adoption model for DPV adoption





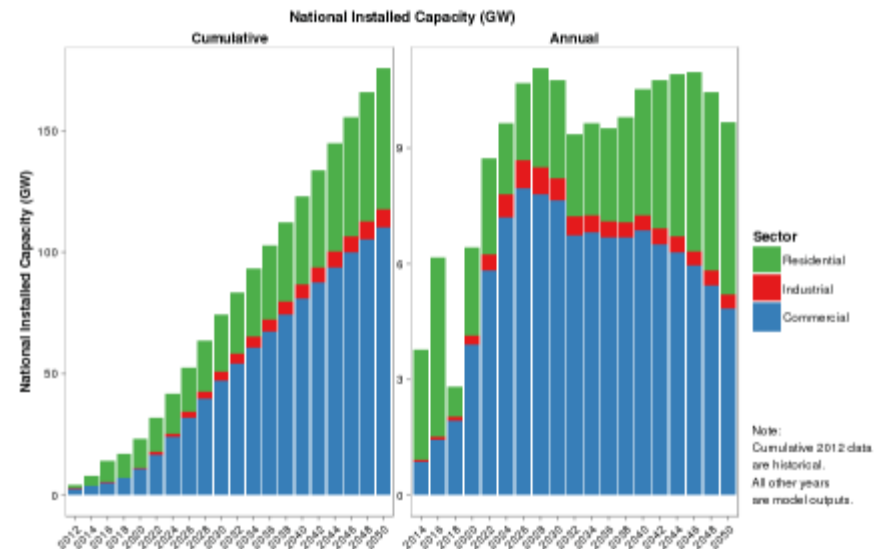
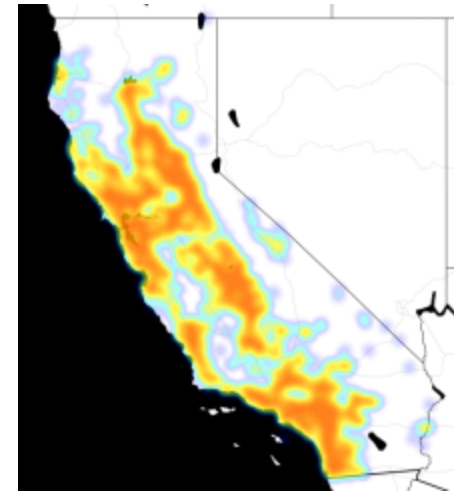
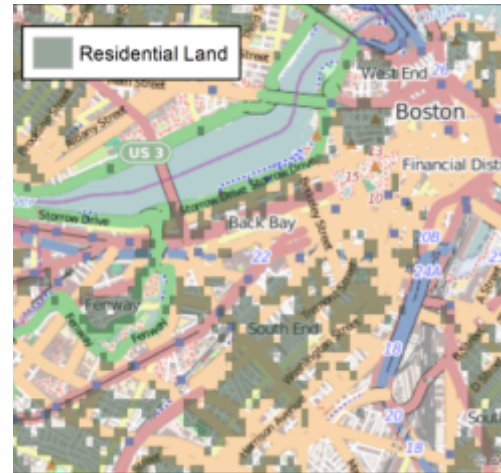
# Regional Energy Deployment System (ReEDS) Model



- Central-planning optimization model of U.S. Electricity Sector
- 134 Balancing Areas
- 356 Wind/CSP regions
- Explicit consideration of RE integration issues
- Solves combined capacity expansion and dispatch out to 2050 under different assumptions
  - Economic
  - Technology
  - Policy

# Distributed Generation (dGen) Model

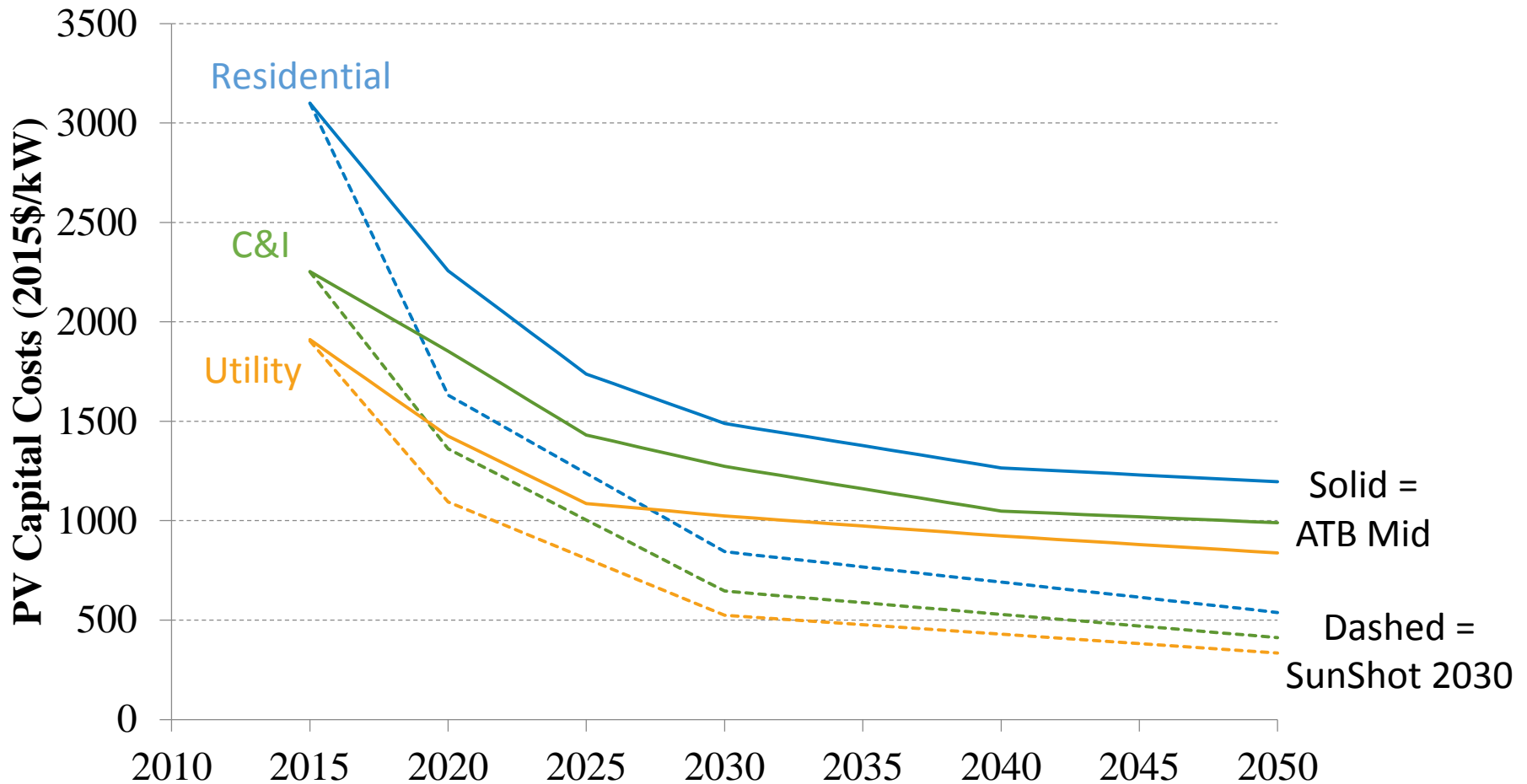
- Distributed generation adoption is modeled in an exogenous module
- dGen forecasts adoption of distributed generation (solar, storage, wind, heat pumps) by sector in the continental U.S. through 2050
- Agent-Based Model simulating consumer decision-making
- Incorporates detailed spatial data to understand regional markets and trends



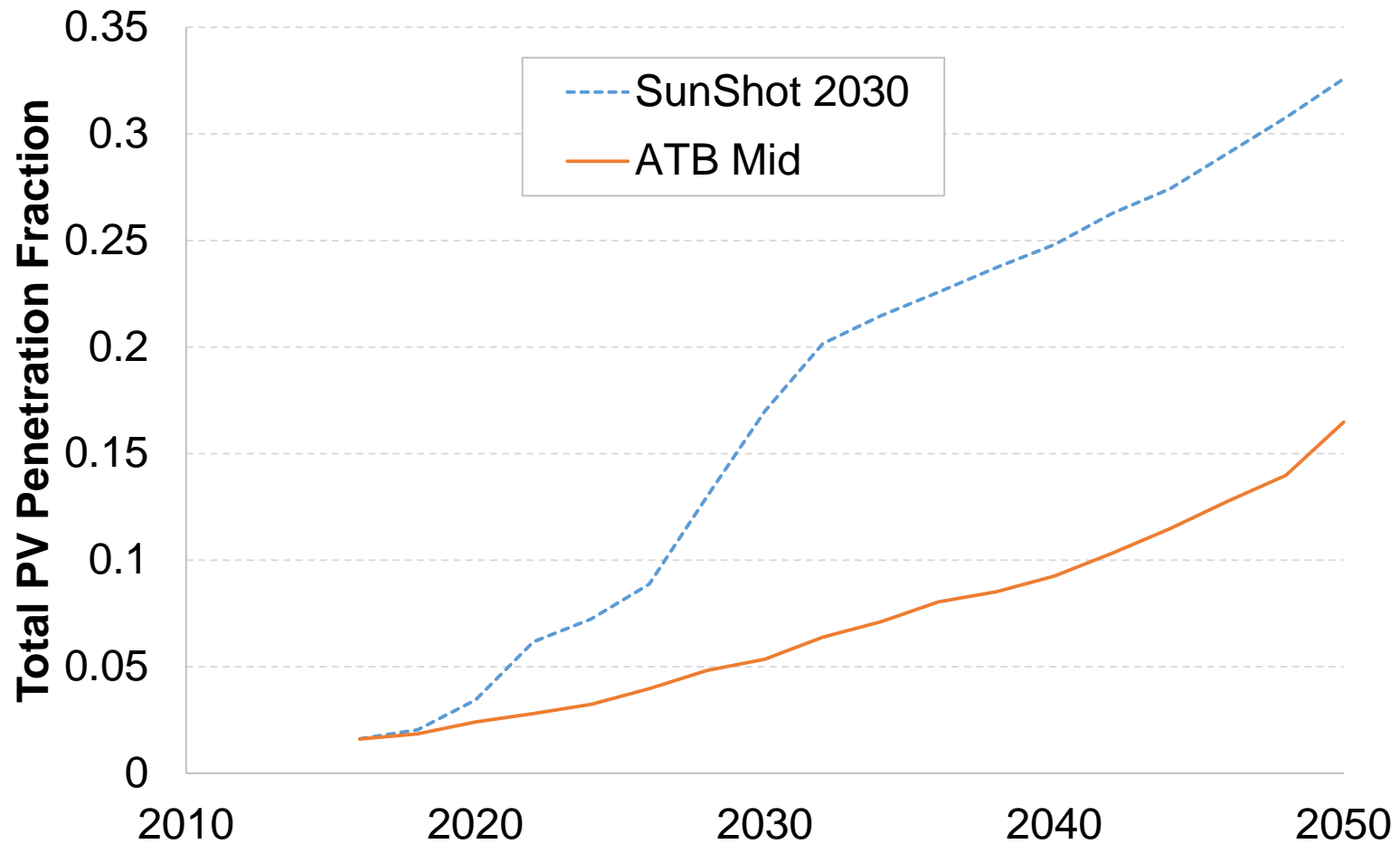
(Top Left): Evaluate adoption potential for each 200m<sup>2</sup> cell; (Top Right): Spatial focus permits regional predictions; (Bottom): Results from BAU-Mid Costs Scenario in ITC Extension analysis

# Scenarios

- Reference: 2016 ATB Mid PV prices
- SunShot: SunShot 2030 PV prices



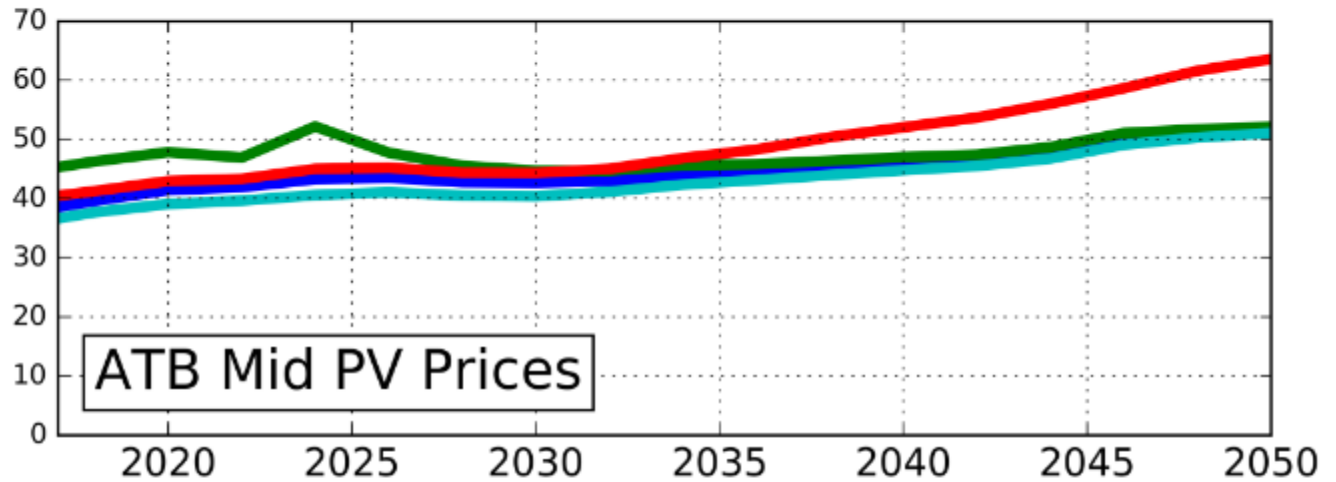
# Impact of PV Capital Costs on PV Deployment



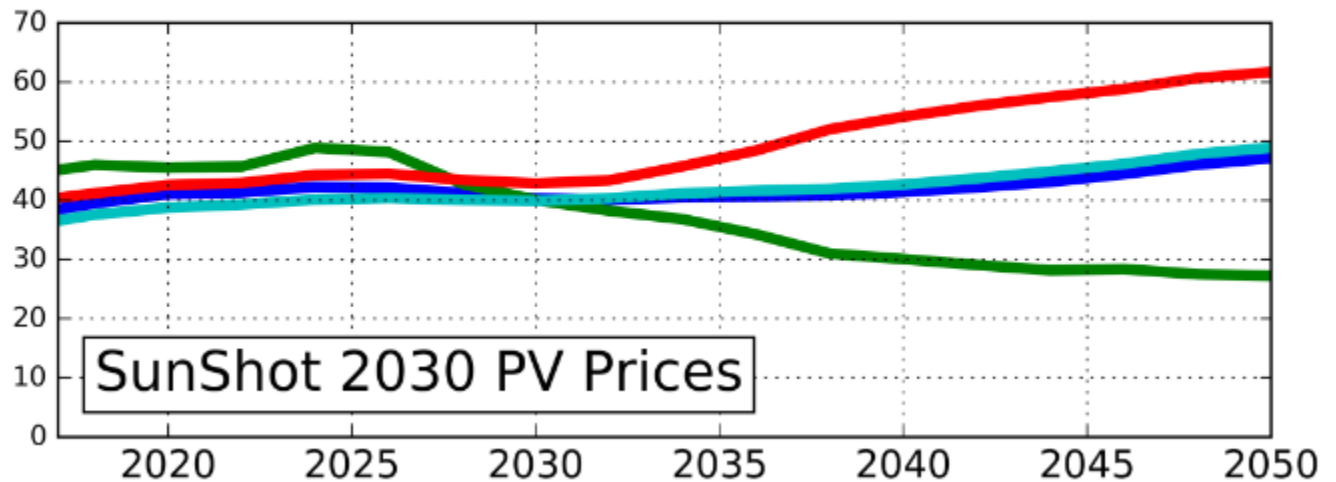
# Resulting Electricity Prices

- Morning: 6AM-1PM
- Afternoon: 1PM-5PM
- Evening: 5PM-10PM
- Night: 10PM-6AM

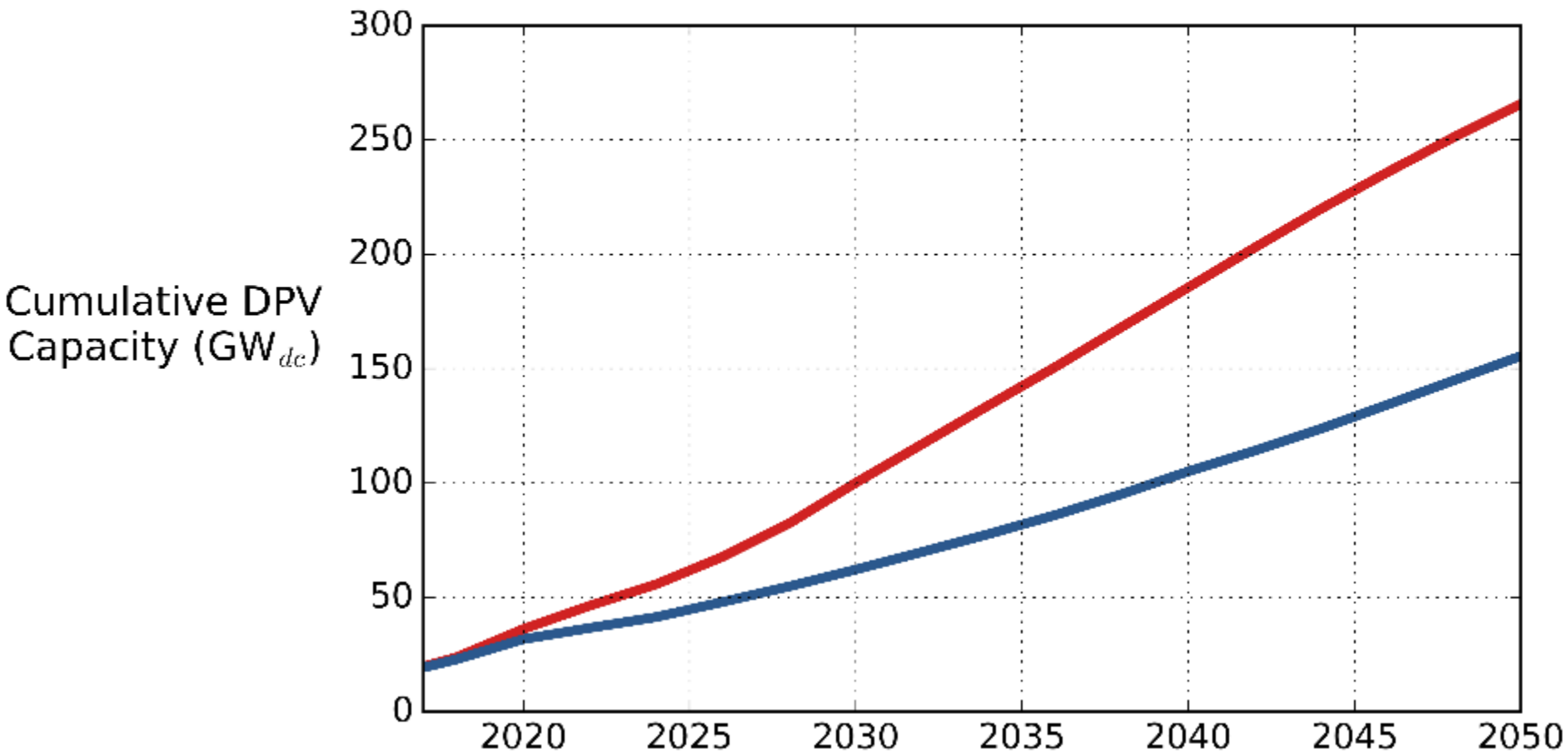
Average marginal cost of Energy (2017\$/MWh)



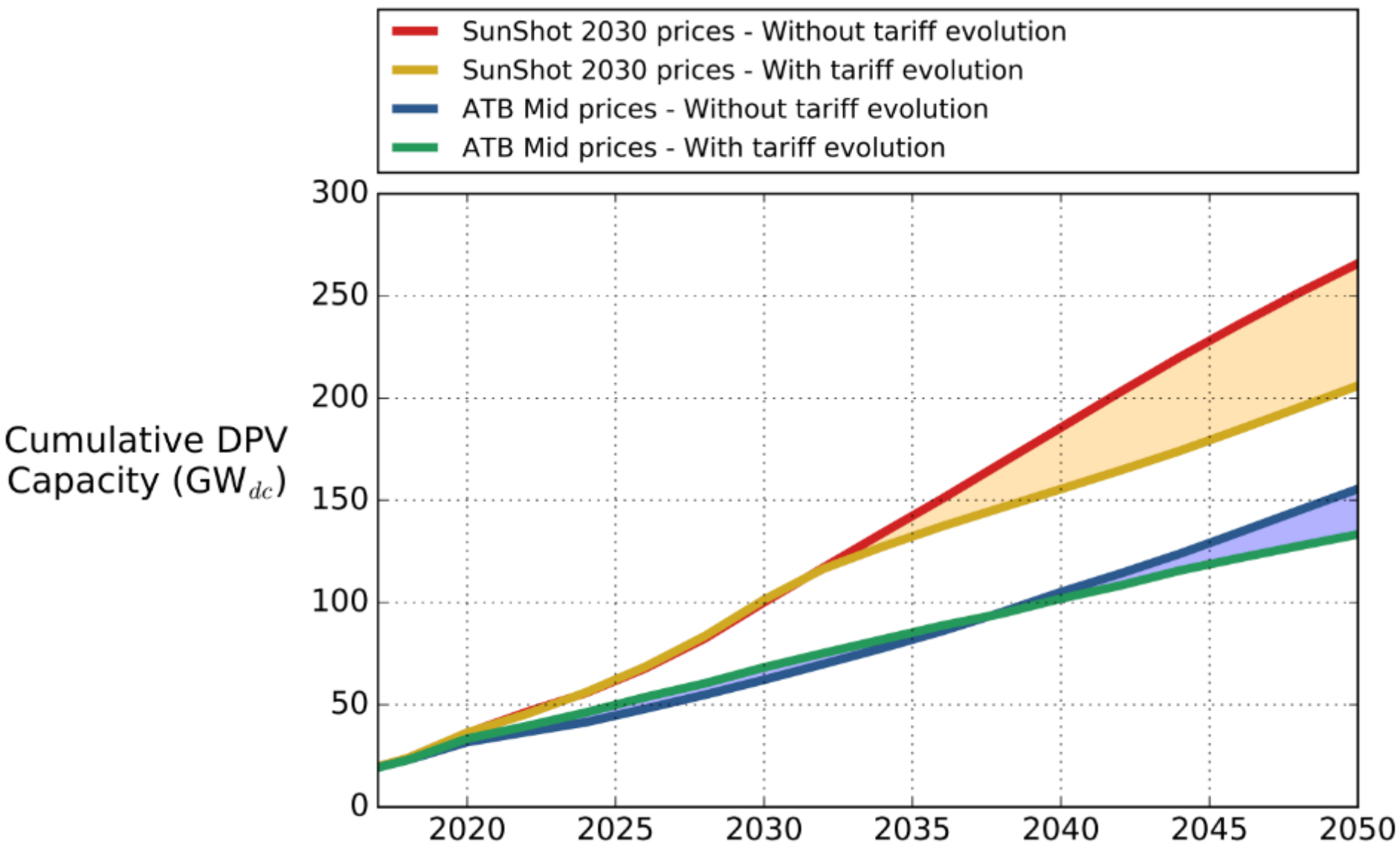
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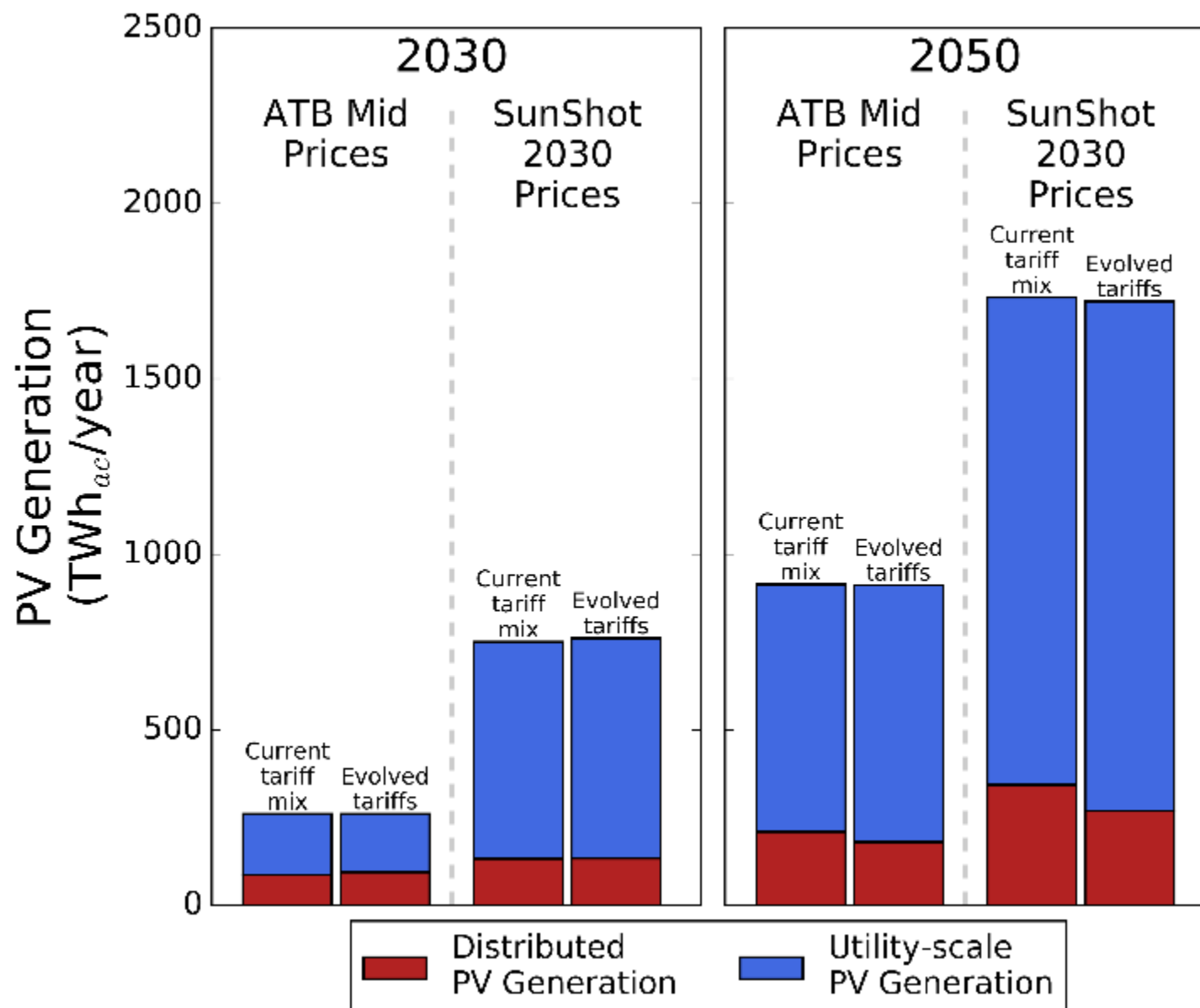
# Impact of Tariff Evolution on DPV adoption



# Impact of Tariff Evolution on DPV adoption



# Minimal Impact of Tariff Evolution on Total PV Generation





# Summary

- Marginal value of PV declines as penetration increases
- Higher penetrations of PV lead to lower afternoon electricity prices
- If these lower electricity prices are communicated back to consumers, DPV adoption slows
- However, DPV adoption still grows 8-16 fold from 2016 levels in the scenarios considered
- Total PV generation not significantly impacted by level of DPV adoption

# Future Work

- We only considered PV prices as a driver for increasing PV deployment. Other drivers might have different impacts
  - High natural gas prices
  - Renewable portfolio standards
  - Carbon tax
- We do not model any elasticity of demand as prices changes
  - Lower afternoon prices might incentivize increased consumption during the afternoon, which would in turn increase the value of PV

# Thank You!

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