



ENERGY



# Pathways to Sustainable Energy

## The Role of Renewable Energy

*Energy Ministerial and 9th International  
Forum on Energy for Sustainable  
Development*

*12-15 November 2018, Kyiv, Ukraine*



# Model Overview

## GCAM: Global Change Assessment Model

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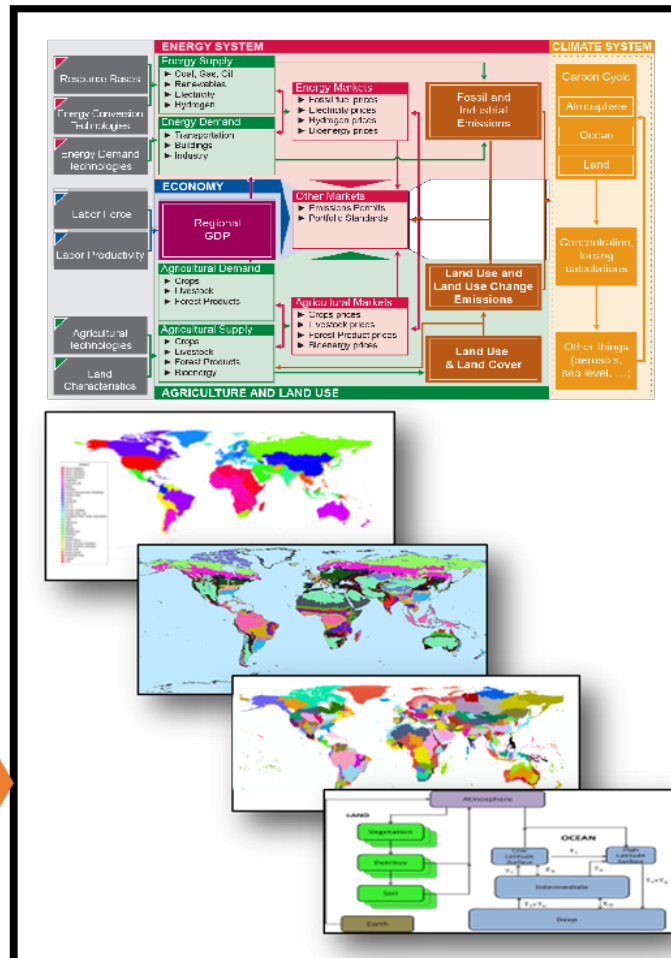


### Scenario Assumptions

- Socioeconomic assumptions (population, GDP)
- Energy, land use, and water technologies
- Policies
- Resources

### Scenario Outputs

- Prices and production quantities:
  - Energy sectors
  - Transportation
  - Primary energy resources
  - Agricultural products
- Land use
  - Crops (by type)
  - Pasture
  - Unmanaged
- Water demand
  - Raw demand by sector
  - Response to scarcity
- Atmosphere-Climate
- Economic indicators
  - Economic losses
  - Income transfer



# Review of GCAM scenarios

Policy & Technology

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**We explore Energy Sustainability using  
scenarios**

**We explore two dimensions**

**POLICY**

**TECHNOLOGY  
(Renewables)**

# GCAM: Preliminary Modeling Results

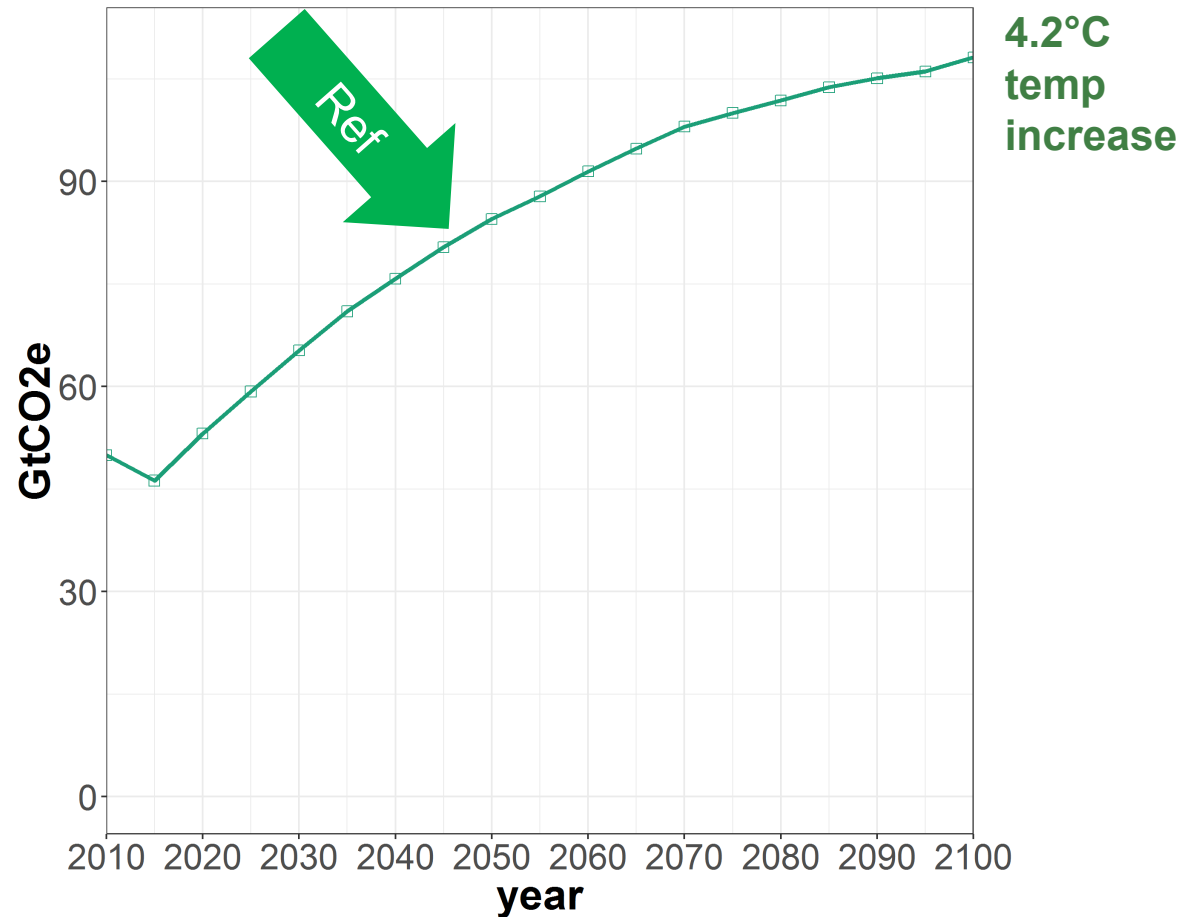


Exemplary results: “Energy and Environment”

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## GHG emissions and temperature rise

Global GHG emissions (GtCO<sub>2</sub>e)



**Reference:** SSP2 assumptions lead to >4 degree climate change by 2100

# GCAM: Preliminary Modeling Results

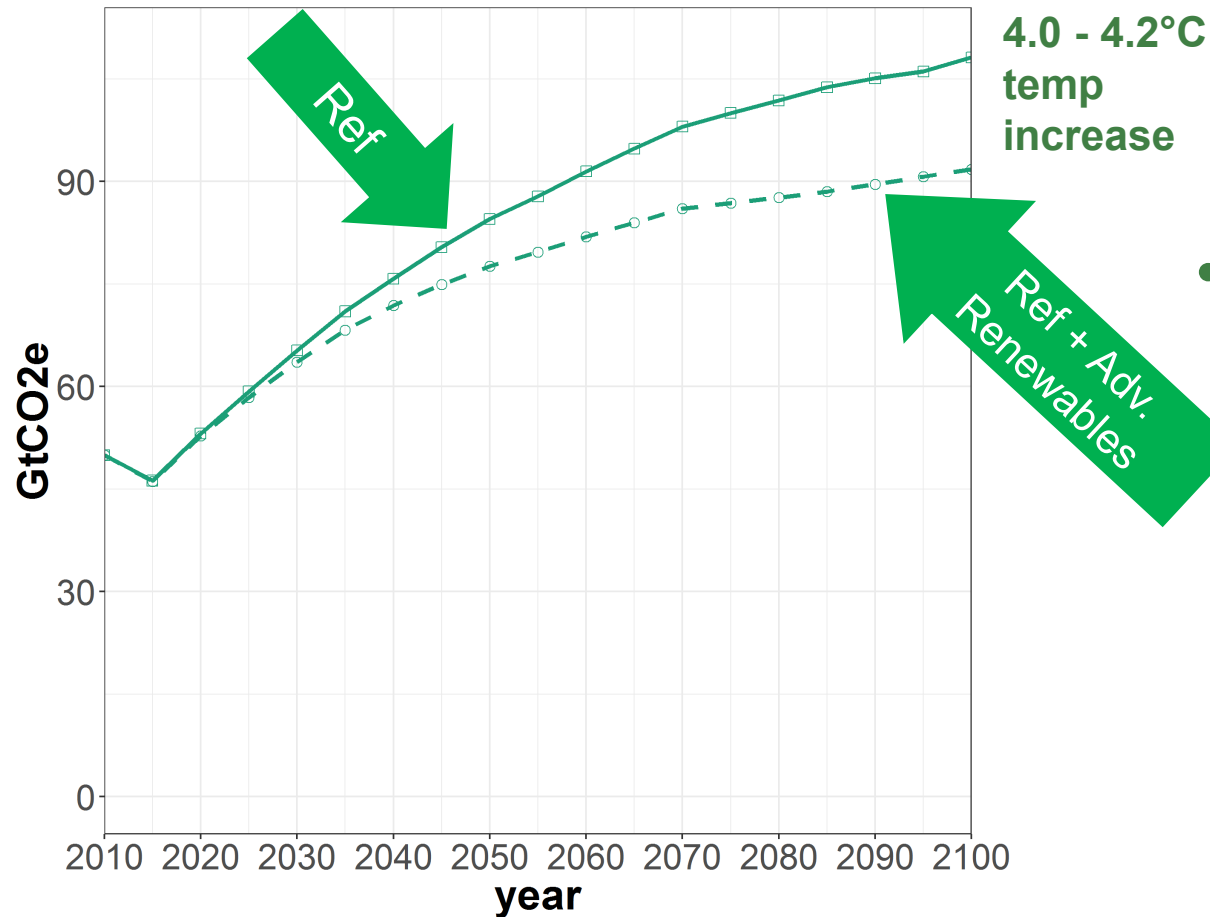
Exemplary results: “Energy and Environment”

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## GHG emissions and temperature rise

Global GHG emissions (GtCO<sub>2</sub>e)



- **Reference: SSP2 assumptions**
  - Reference technology
  - Advanced renewables

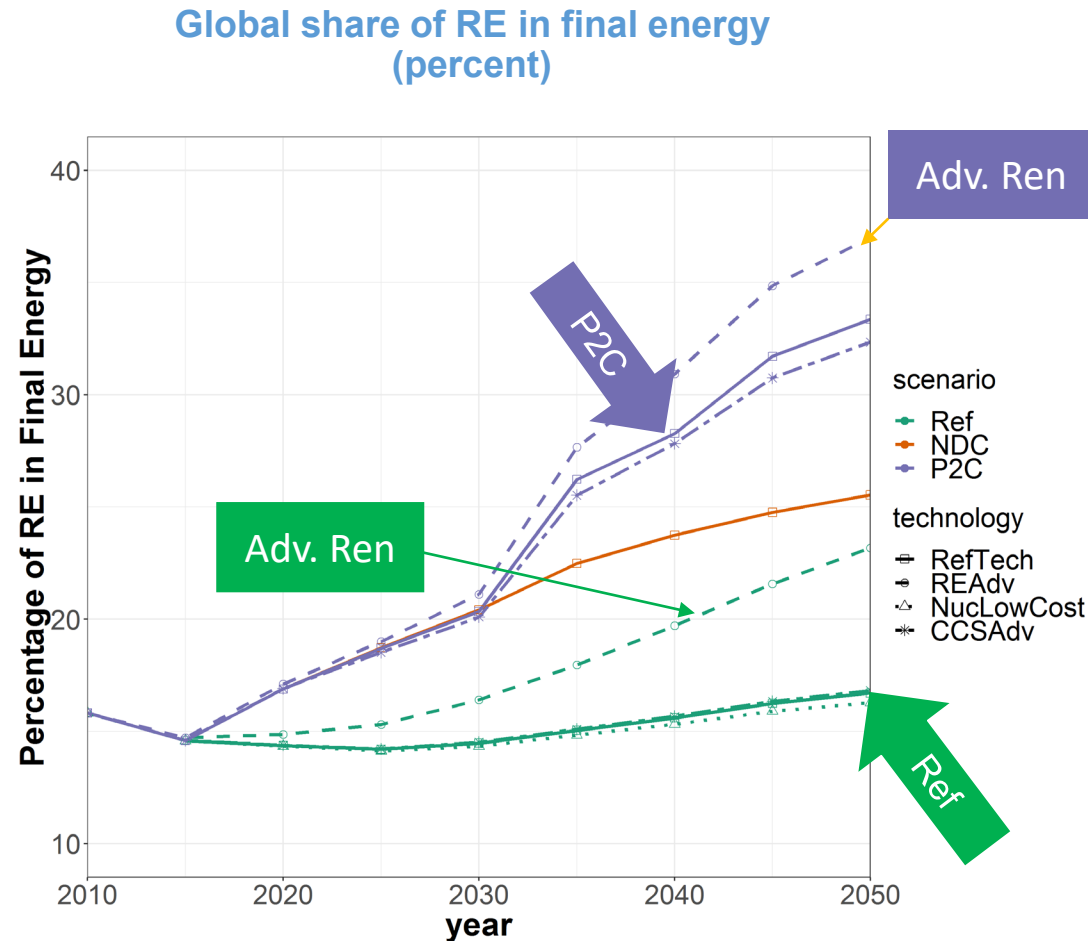
# GCAM: Preliminary Modeling Results

Exemplary results: “Energy Security”

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- Renewable Energy Share in Final Energy Use
- Advanced RE increases the RE share of final energy in the Reference and P2C scenarios
- Other technologies have minor impact on the RE share in final energy in the Reference scenario



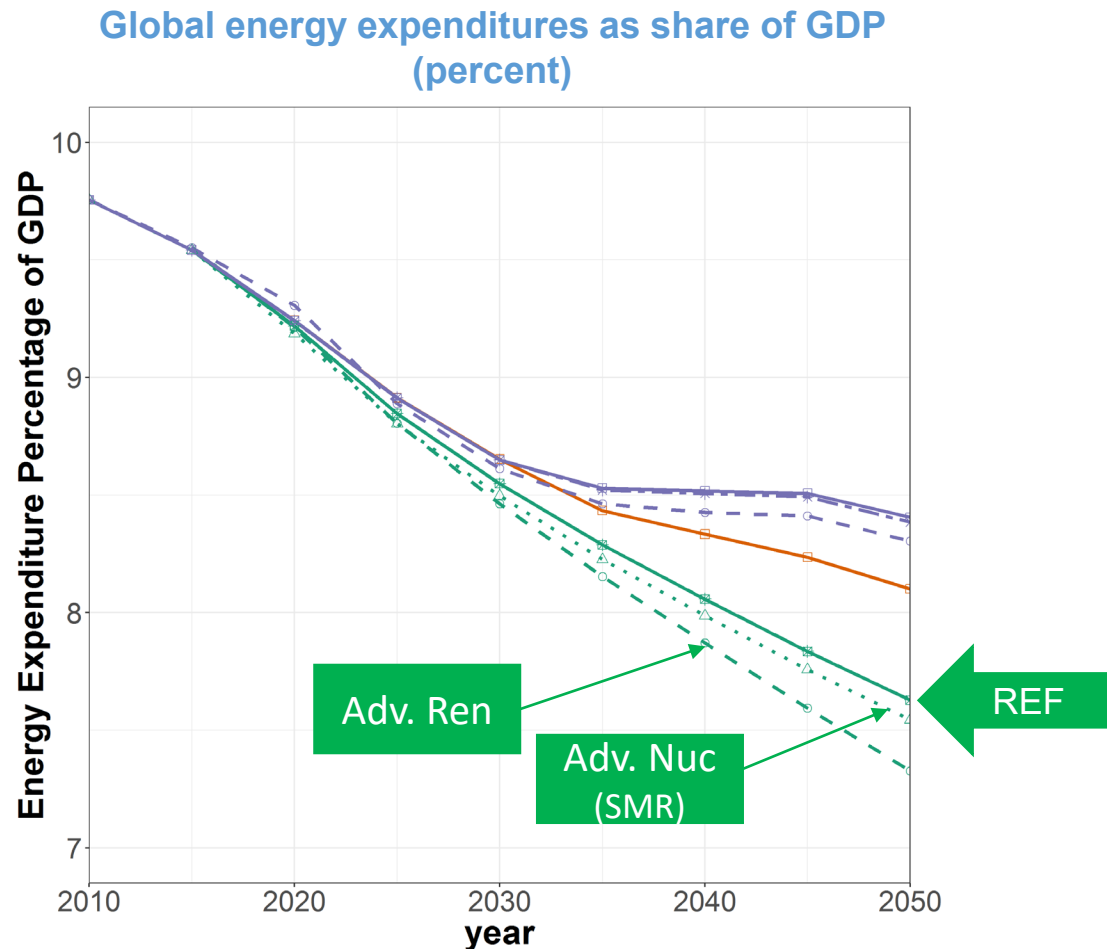
# GCAM: Preliminary Modeling Results

Exemplary results: “Quality of Life”

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- Energy Expenditure Relative to GDP
- Advanced renewable technologies help reduce the policy impact.



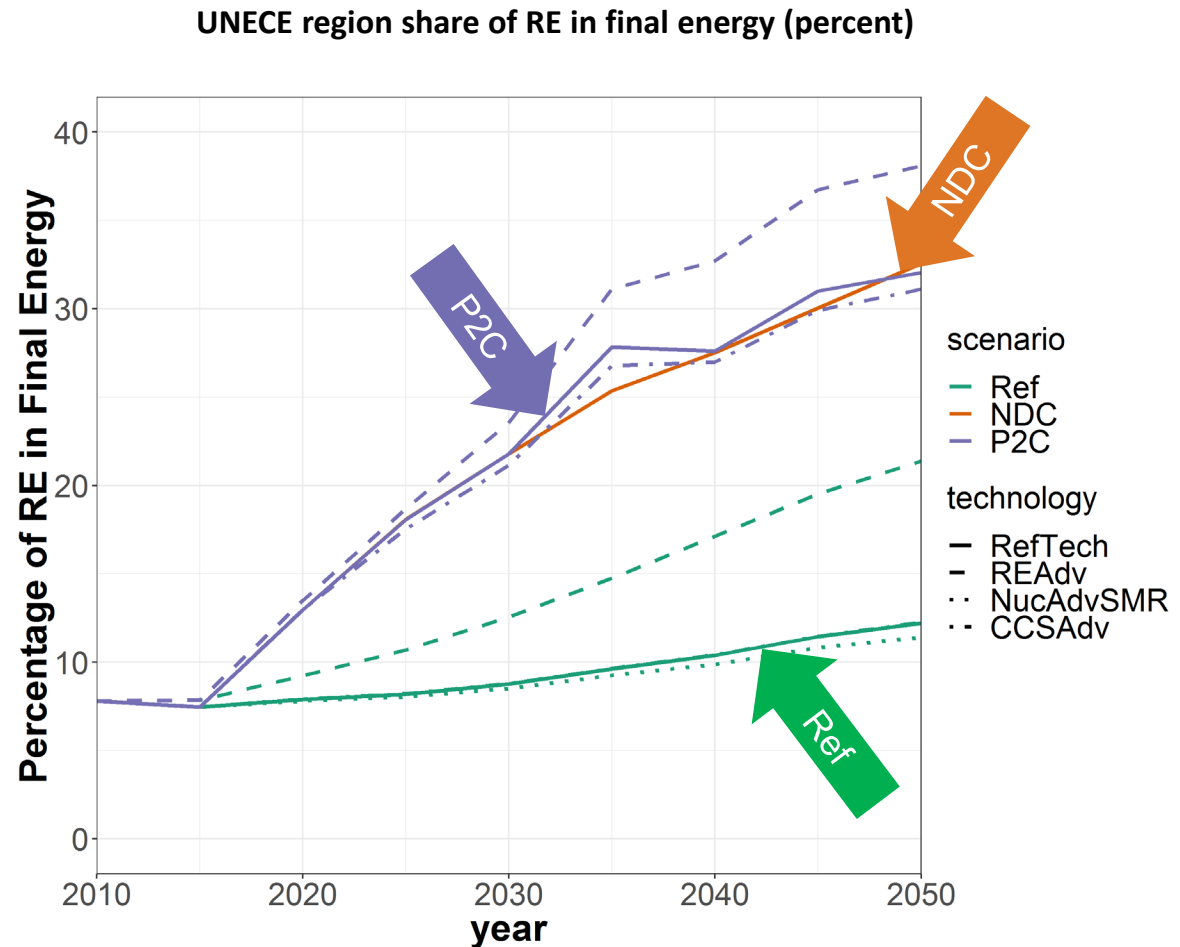
# GCAM: Preliminary Modeling Results

## ES-M3: Increase Renewable Energy

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- **Renewable Energy Share in Final Energy Use**
- Renewable energy use rises with mitigation ambition
- None of the scenarios meet the SE4all 2030 target (36%).
- Advanced RE has significant impact on SSP2, current policies.





# MESSAGE: Preliminary Modeling Results

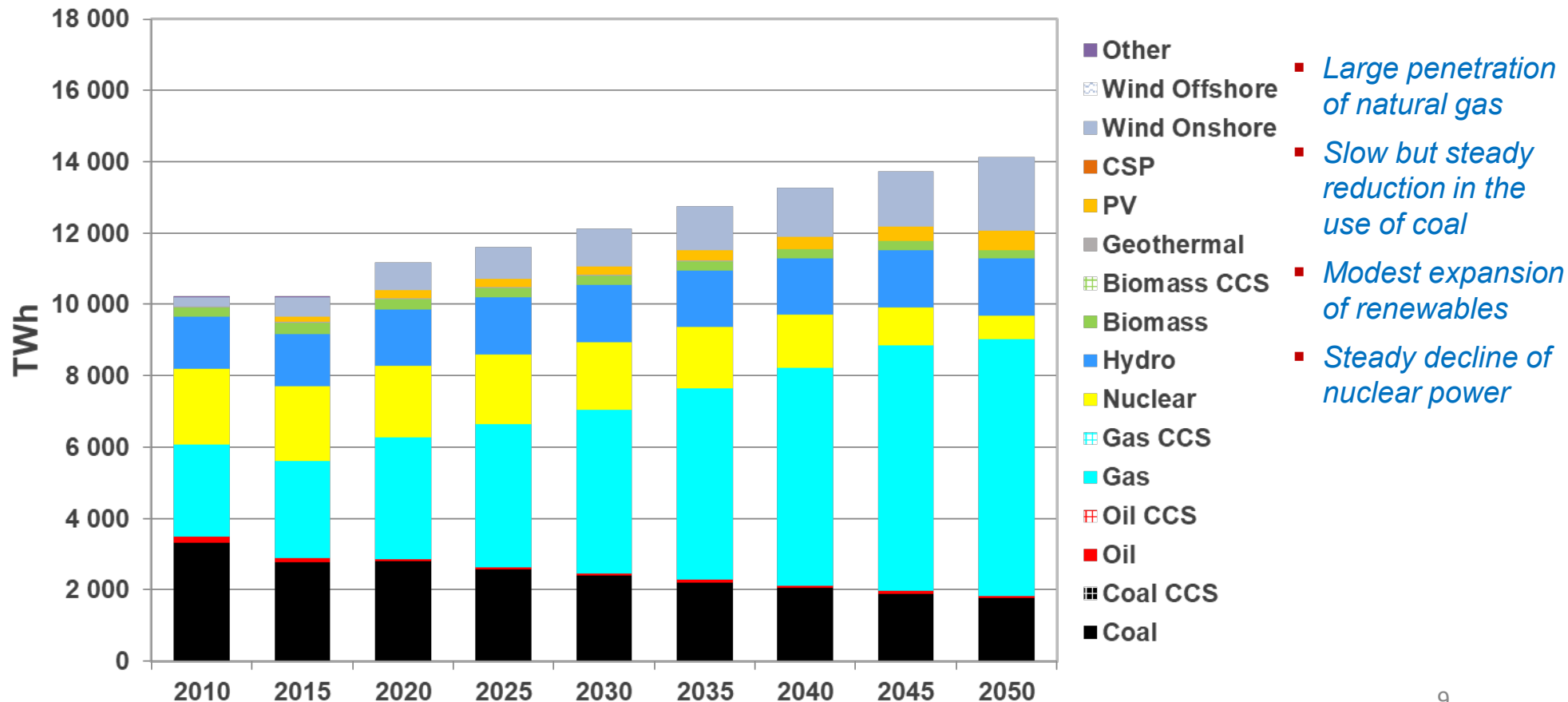
## Electricity Generation

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### Electricity generation by technology, UNECE

#### *Reference technology dynamics*



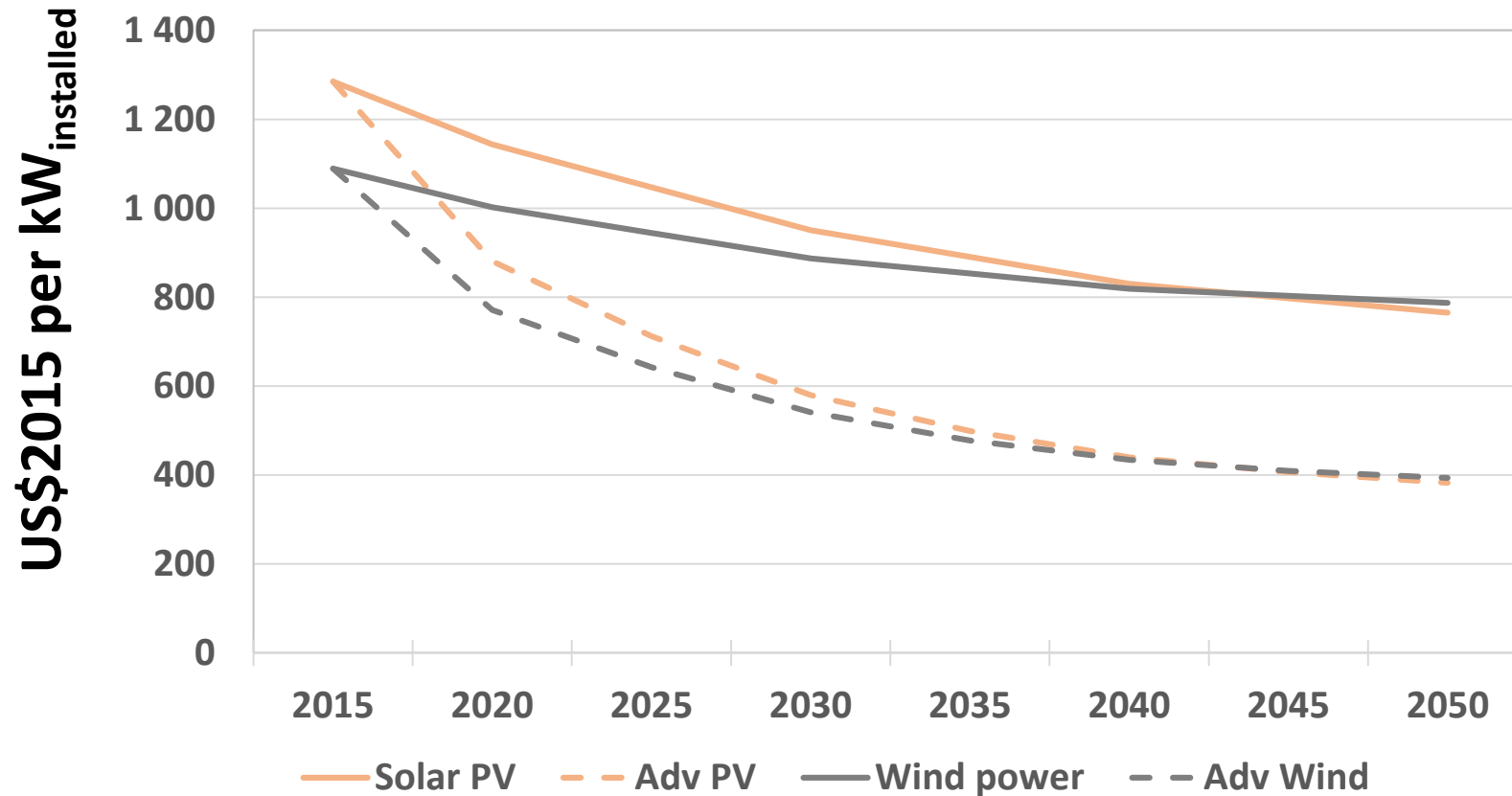
# MESSAGE: Preliminary Modeling Results

Renewables: The role technology change

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## Advanced renewable technology dynamics



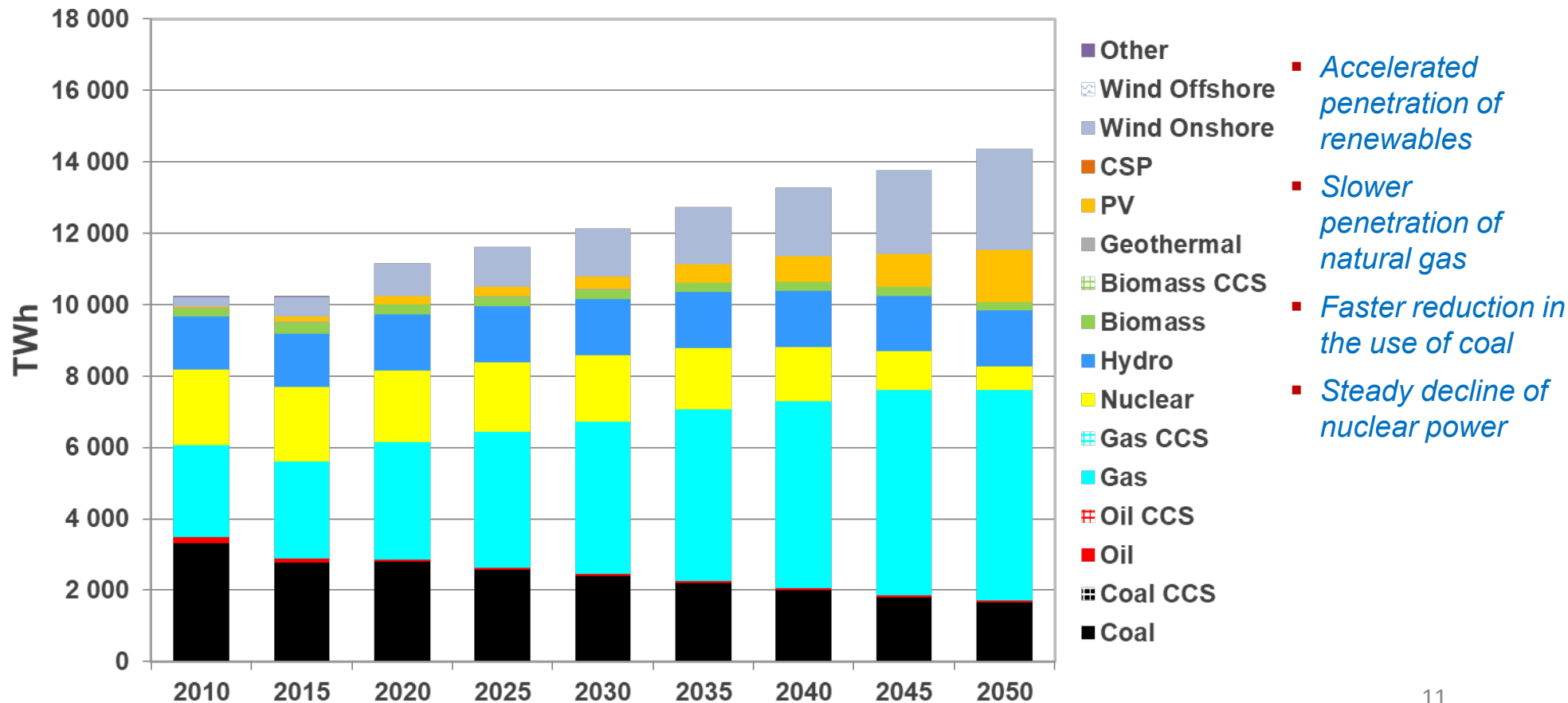
# MESSAGE: Preliminary Modeling Results

## Electricity Generation: The Role of Renewables

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### Electricity generation by technology, UNECE *Advanced renewable technology dynamics*



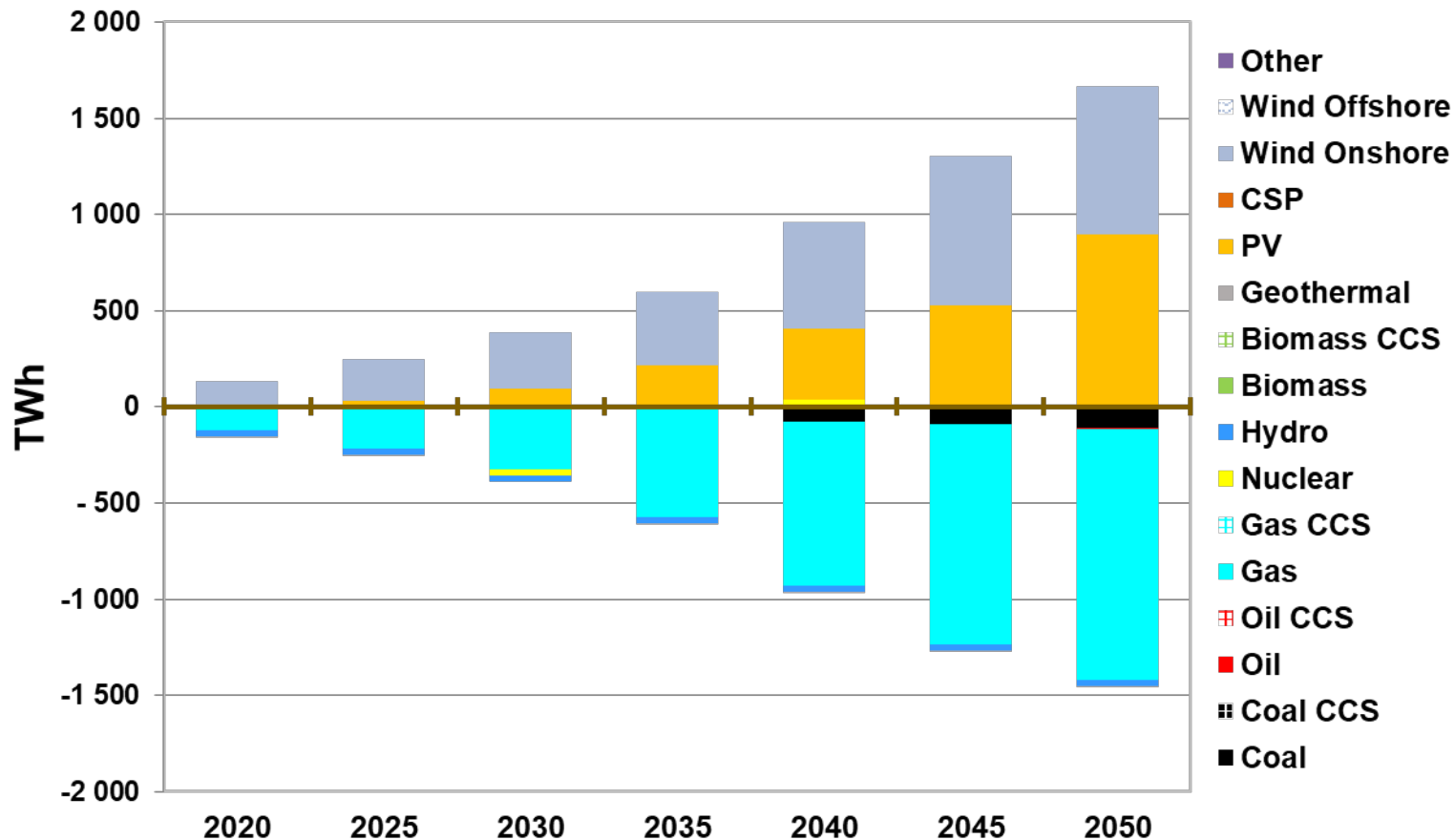
# MESSAGE: Preliminary Modeling Results

## Electricity Generation: The Role of Renewables

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### Electricity generation by technology, UNECE Advanced renewable technology dynamics



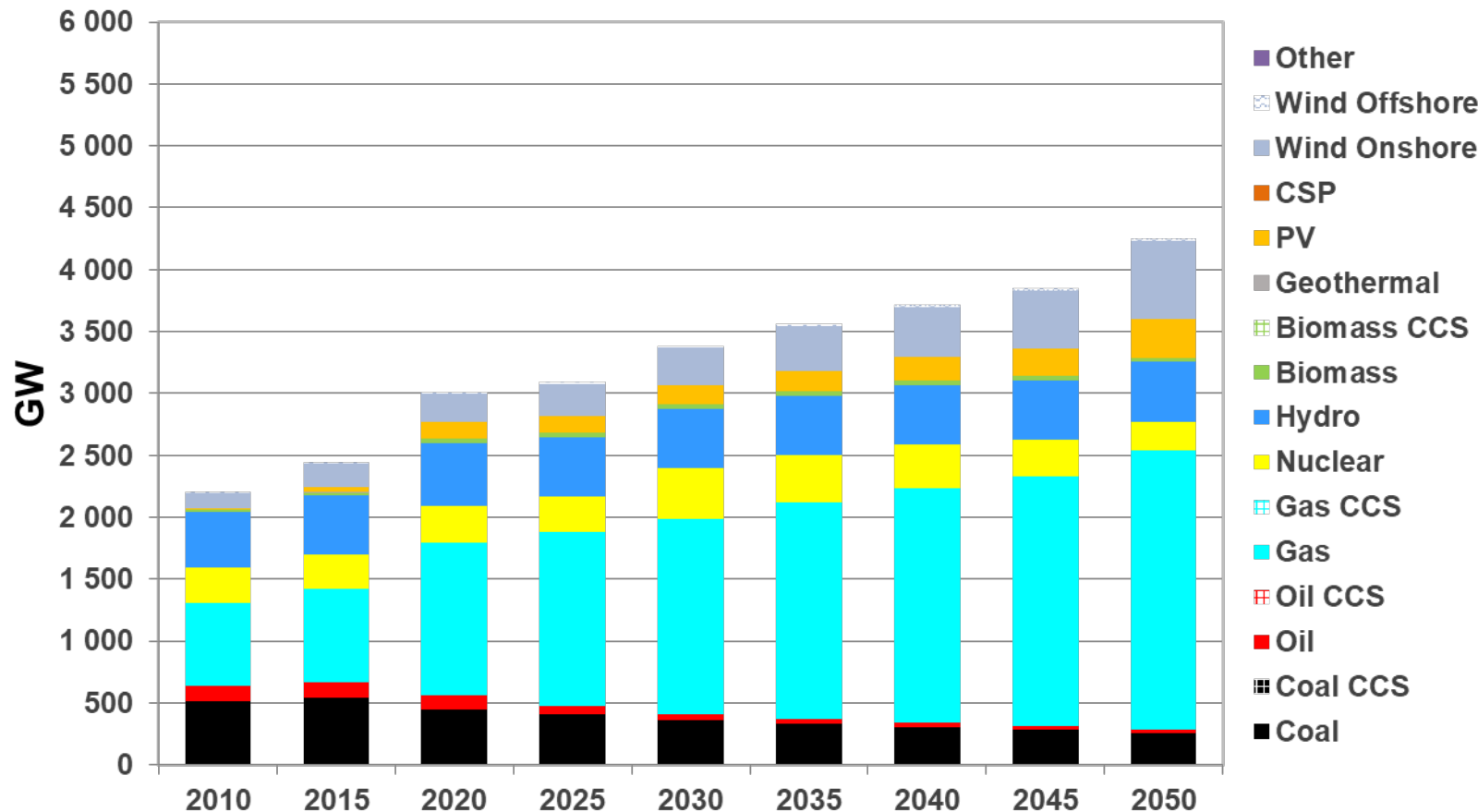
# MESSAGE: Preliminary Modeling Results

Electricity Generation

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## Generating capacity by technology, UNECE *Reference technology dynamics*



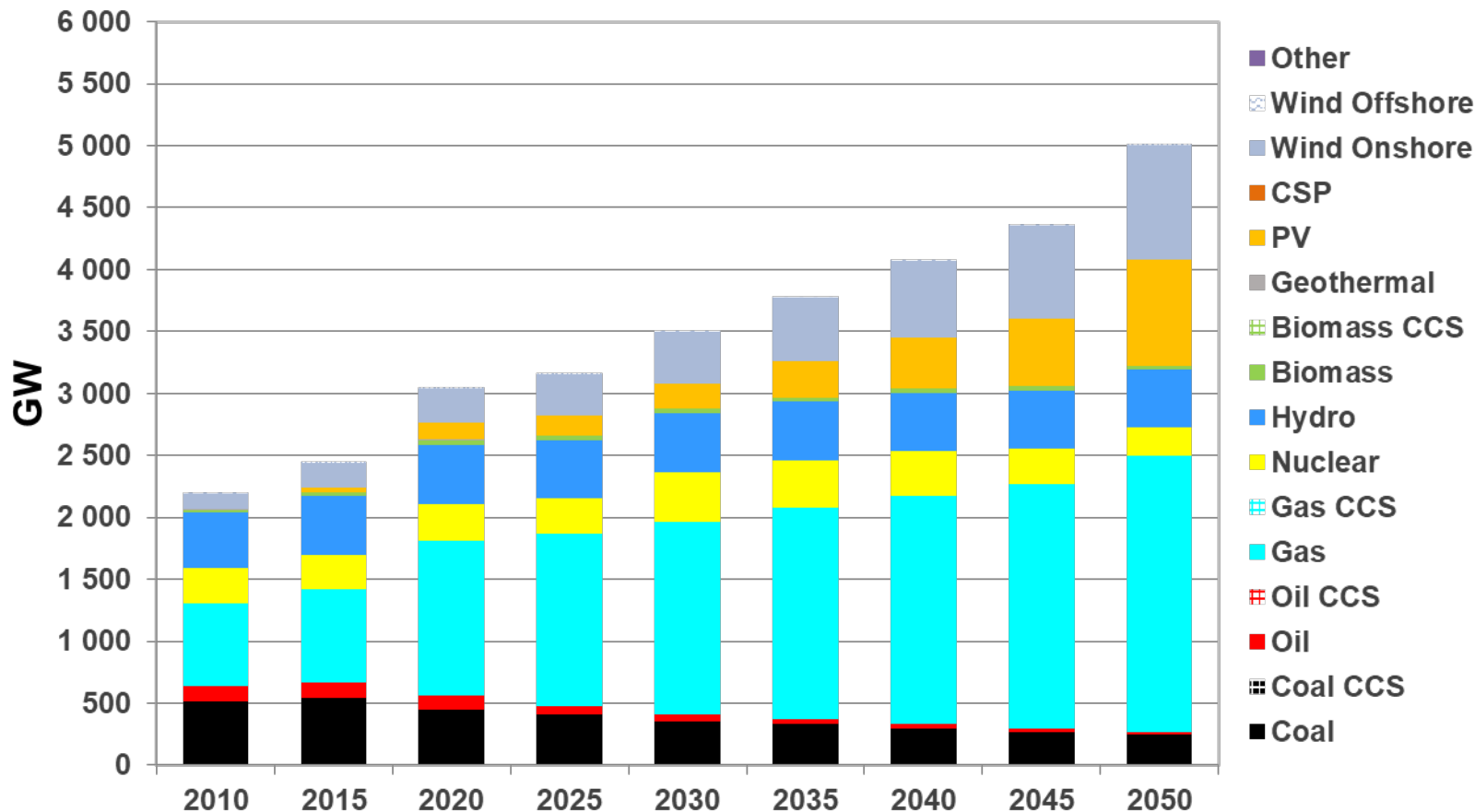
# MESSAGE: Preliminary Modeling Results

Electricity Generation

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Generating capacity by technology, UNECE  
*Advanced renewable technology dynamics*



# MESSAGE: Preliminary Modeling Results

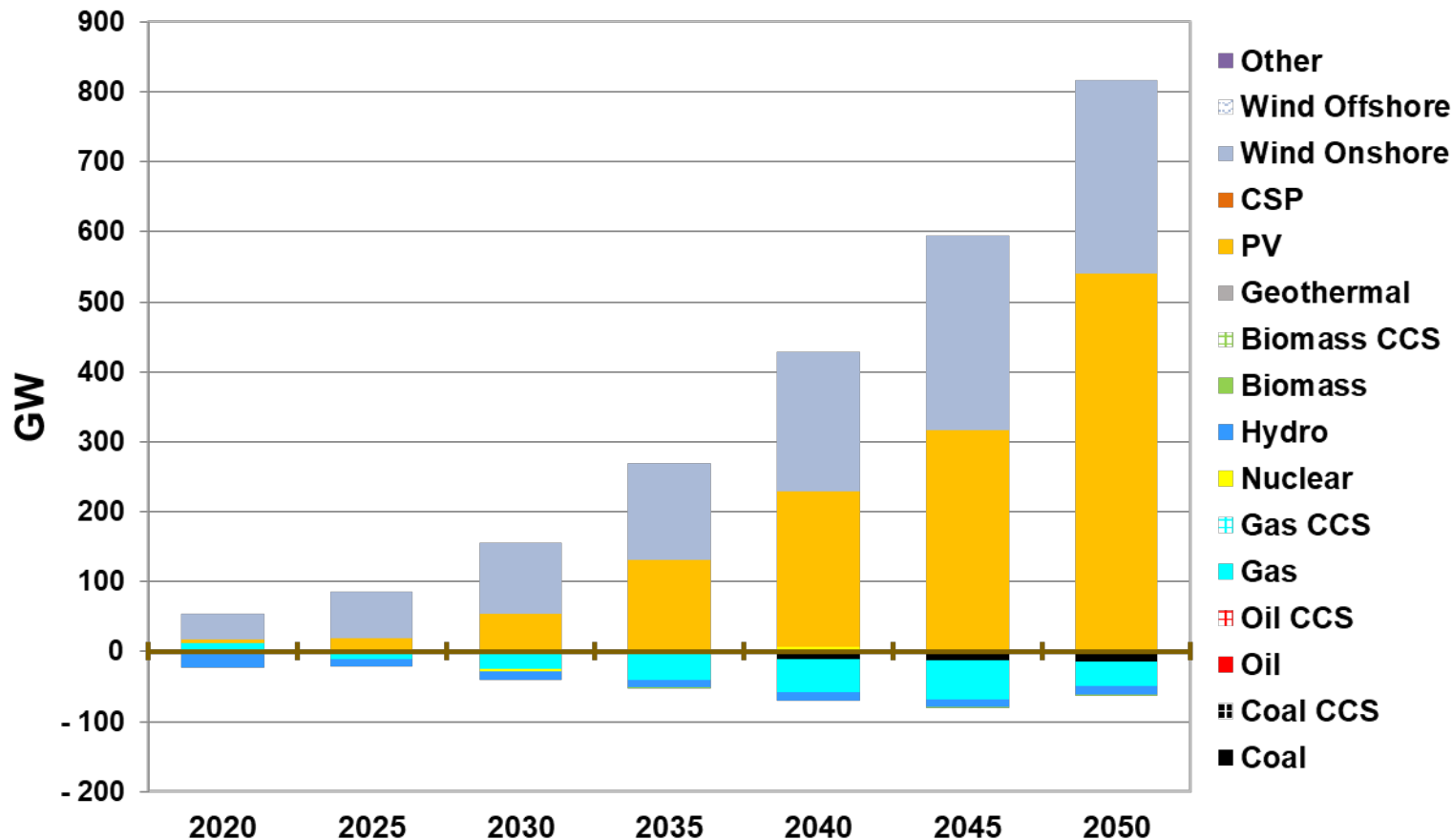
Electricity Generation

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## Electricity capacity by technology, UNECE

*Difference: Adv. RES minus REF*



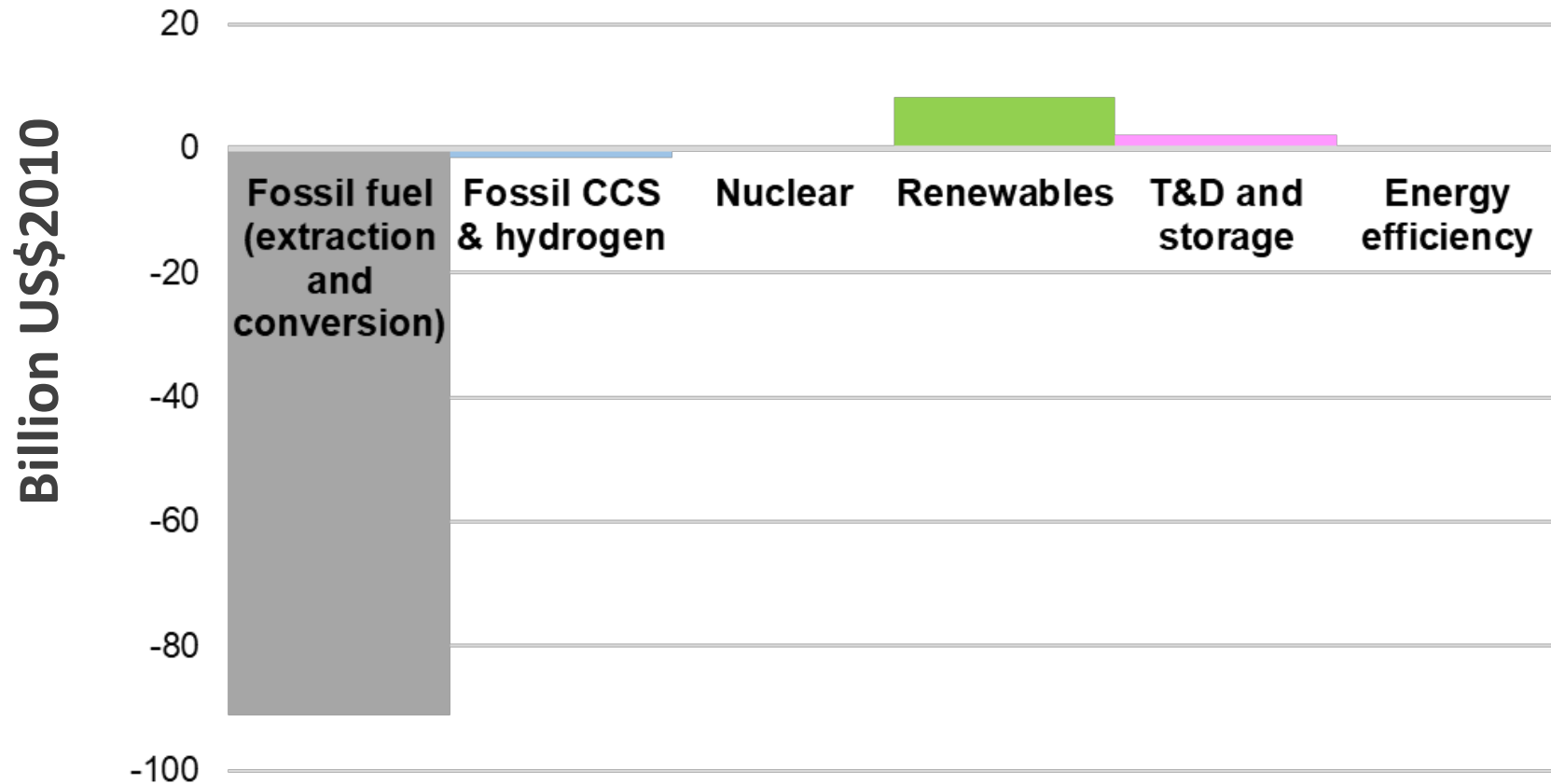
# MESSAGE: Preliminary Modeling Results

Electricity Generation

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Cumulative Investments, UNECE  
*Difference: Adv. RES minus REF*





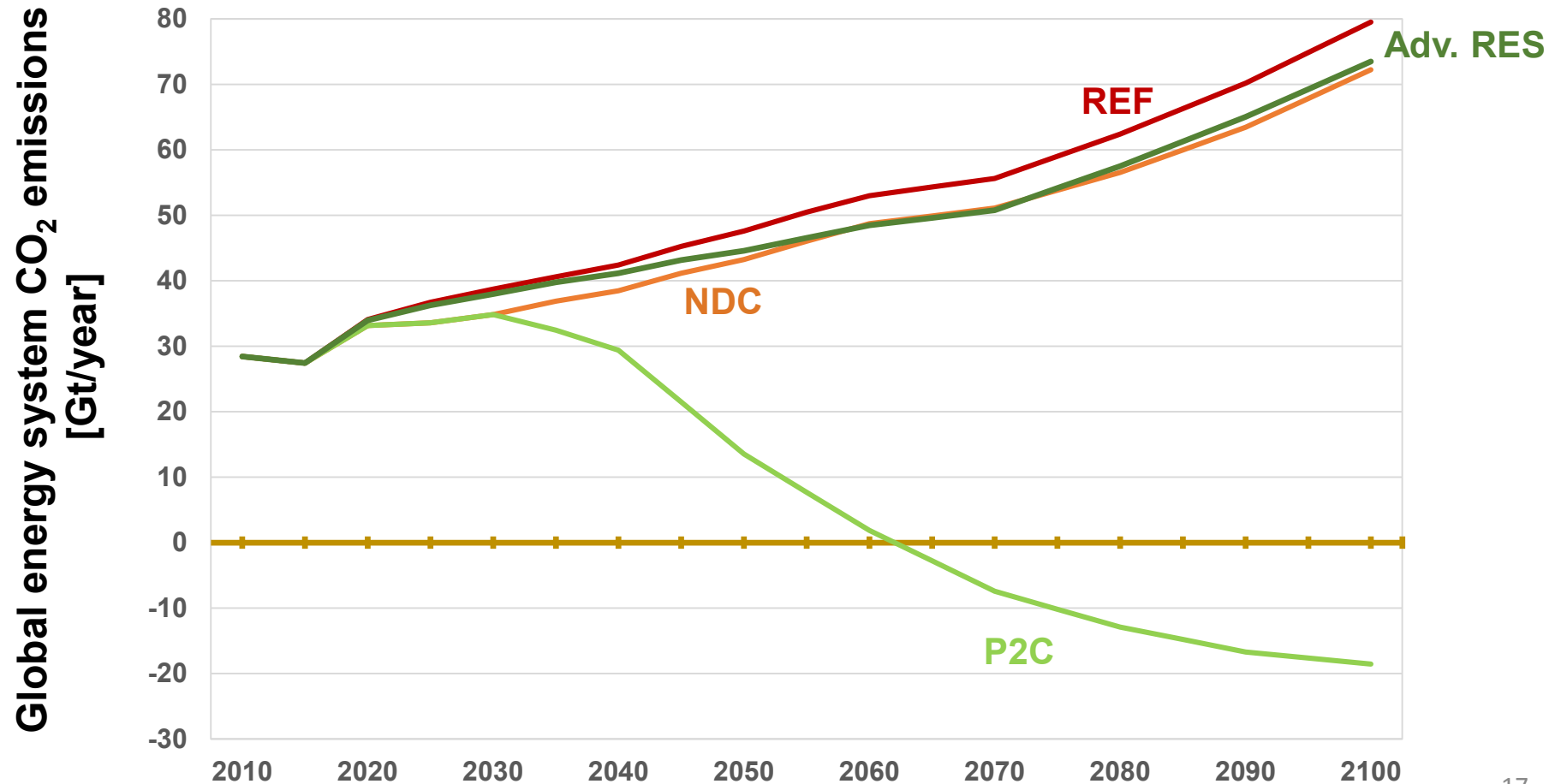
# MESSAGE: Preliminary Modeling Results

EN-M1: Global GHG emissions

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## Global GHG emissions, UNECE Advanced renewable technology dynamics



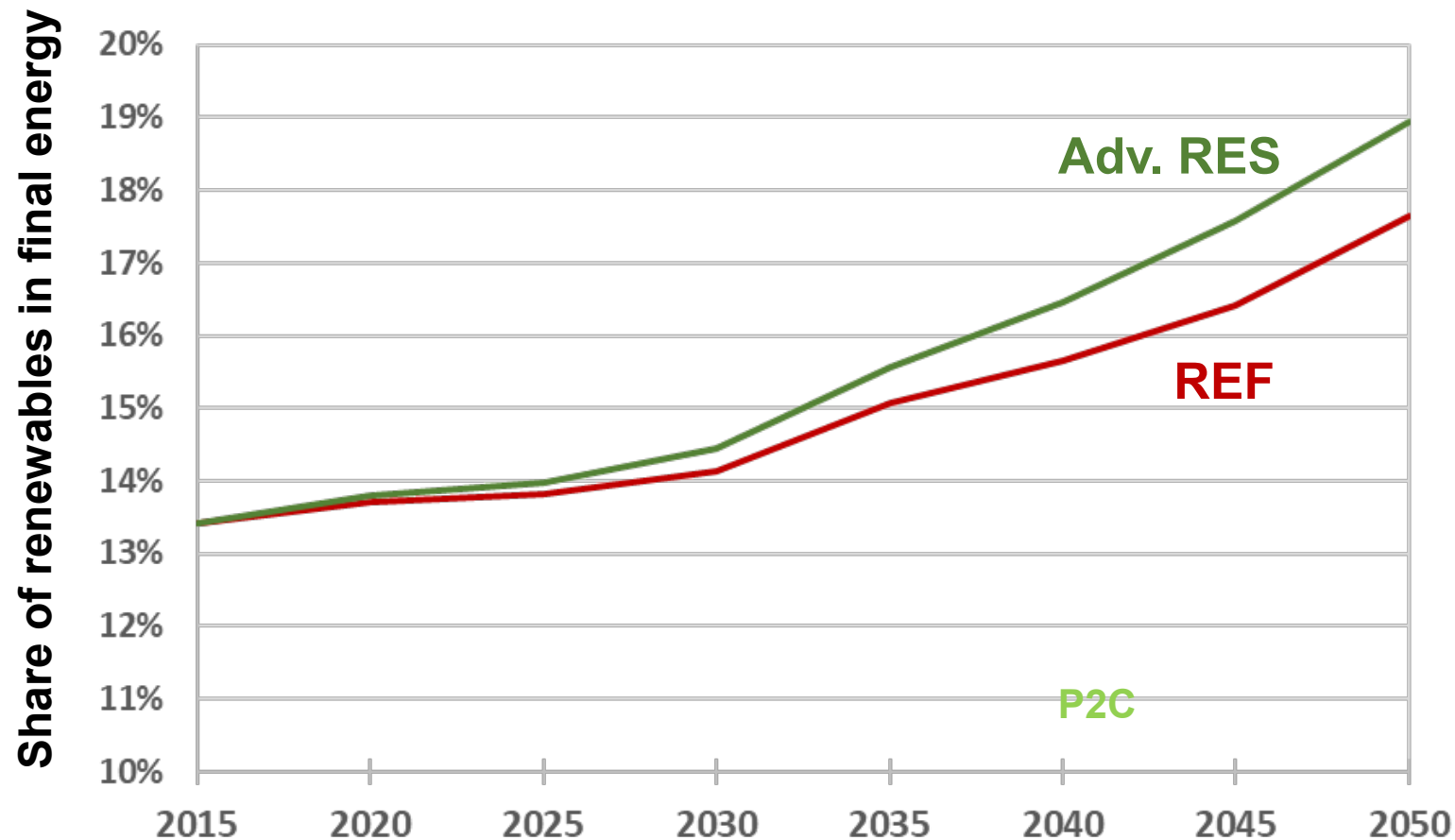
# MESSAGE: Preliminary Modeling Results

EN-M1: Global GHG emissions

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## Global GHG emissions, UNECE Advanced renewable technology dynamics



# Summary Remarks

The role of renewables

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- I. Technology change and technology learning improving the techno-economic performance of renewables advance the market penetration of renewables
- II. Technology change is a necessary but not sufficient condition
- III. Renewable energy use rises with mitigation ambition
- IV. None of the scenarios meet the 36% SE4all target by 2030
- V. Accelerated energy system transformation needs dedicated policy support and agreed performance targets
- VI. Policies towards pathways to sustainable energy futures need to account for trade-offs with other sustainable development goals



# Thank you!

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Date 14 | 11 | 2018, Kyiv

