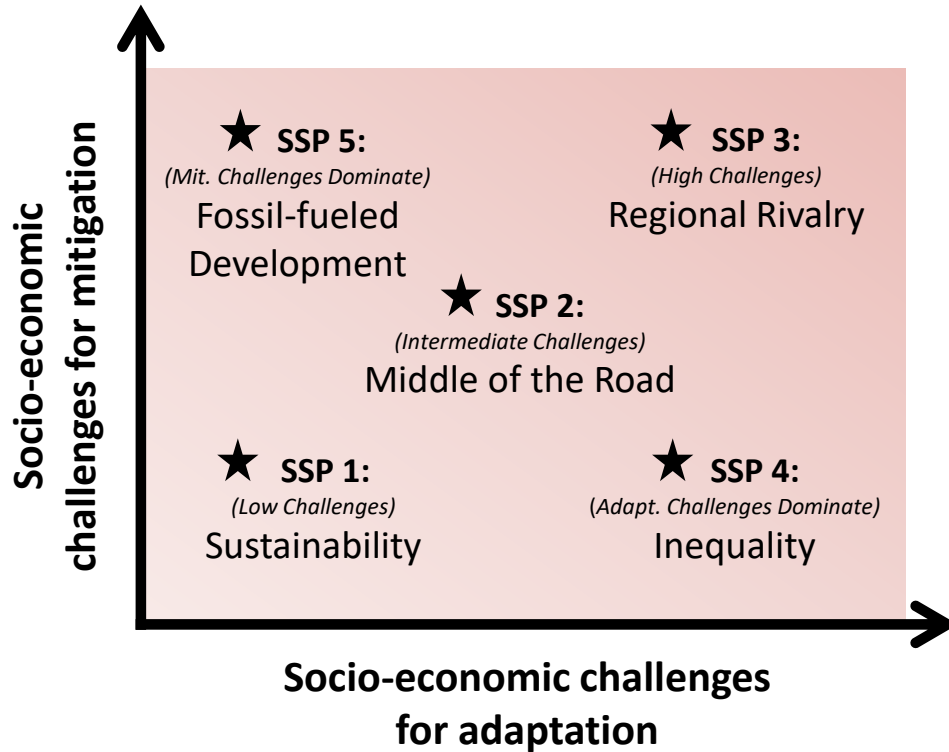


The Impact of Global Energy Scenarios on the UNECE Region and 3R

(The Preliminary Results from MESSAGE model)

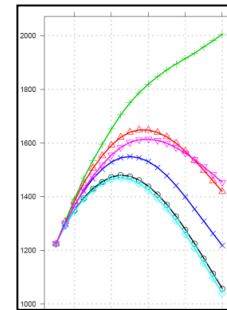
Behnam Zakeri, Holger Rogner, Volker Krey
UNECE Sustainable Energy Pathway Project

Shared Socioeconomic Pathways (SSPs)



Narrative

Qualitative description of broad patterns of development
 Logic relating elements of narrative to each other



Quantitative elements

National:
 Population
 Education
 Urbanization
 GDP
 Technology

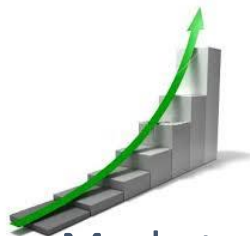
SSP narratives, quantitative elements: **2017 special issue of *Global Environmental Change***.
 SSP Database, hosted by IIASA.

The Scenario Matrix Architecture

Challenge to mitigation

SSP5: Fossil fueled development

- Rapid economic growth, free trade fueled by carbon-intensive fuels
- High technology development
- Low regard for global environment and SDGs
- Technology fixes Low population and high mobility



Markets first



Clash of civilisations

SSP3: Regional rivalry

- Competition among regions
- Low technology development
- Environment and social goals not a priority
- Focus on domestic resources
- High population growth
- Slow economic growth dev. countries

SSP2: Middle of the Road

SSP1: Sustainability

- Global cooperation
- Rapid technology dev.
- Strong env. policy
- Low population growth
- Declining inequity
- Focus on renewables & efficiency
- Dietary shifts
- Forest protection



UN world



Have's and have not's

SSP4: Inequality

- Inequality across and within regions
- Social cohesion degrades
- Low technology development
- Environment priority for the few affluent
- Limited trade

Challenge to adaptation

Reference SSP Scenarios

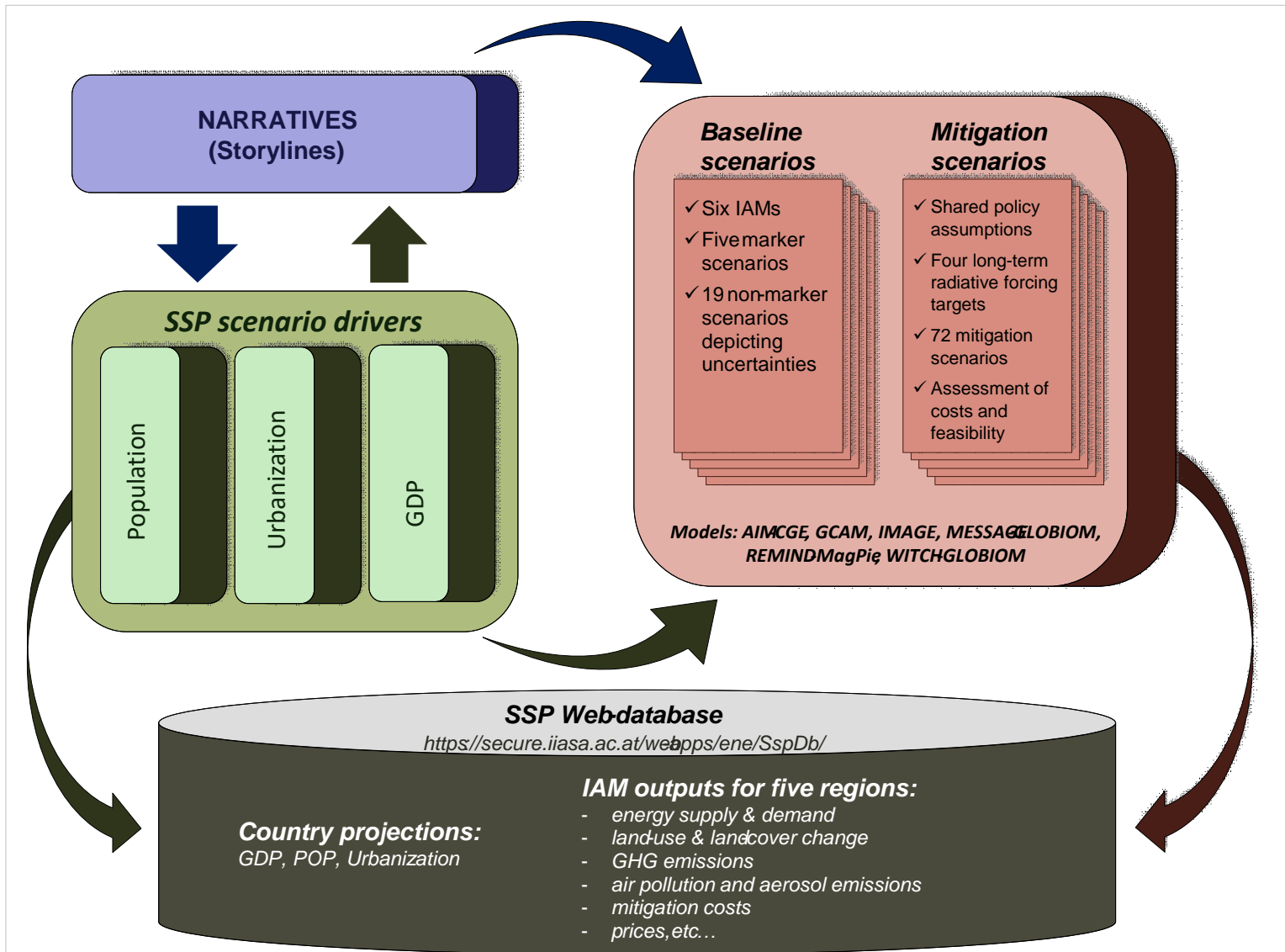
- Well established in the IAM and climate change communities
- Consistent with the Representative Concentration Pathways (RCPs) – SSPs substitute for the key driving forces of future GHG emissions used by RCPs
- No need to add yet another set of scenarios
- Five SSPs cover a wide range of futures
- Six IA modeling teams – different methodologies, geographical resolutions, energy system representation, IAM linkages and features
- One representative Marker Scenario for each SSP
- For each SSP multiple IAM runs exploring uncertainty ranges

SSP2: Middle of the road

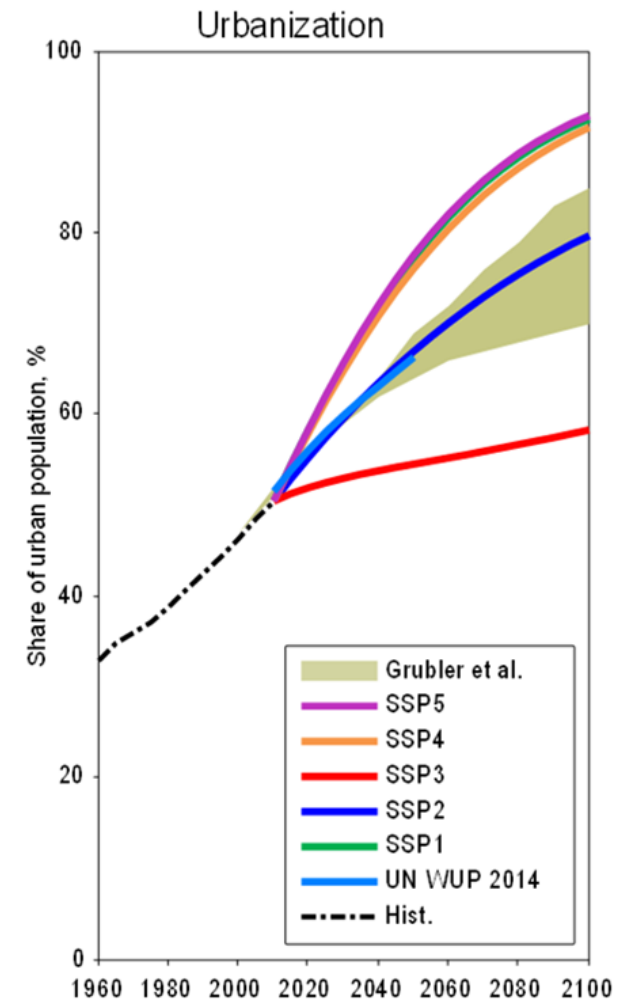
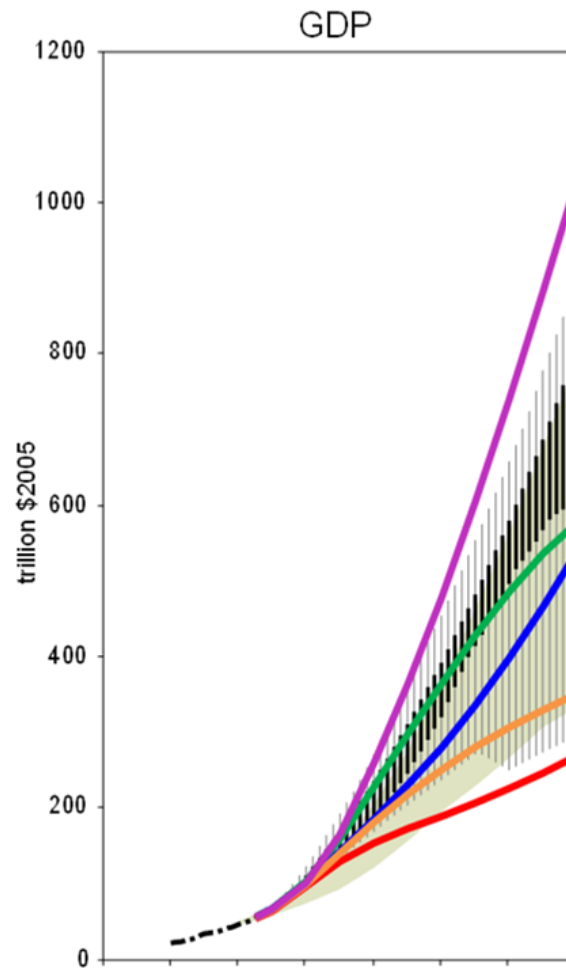
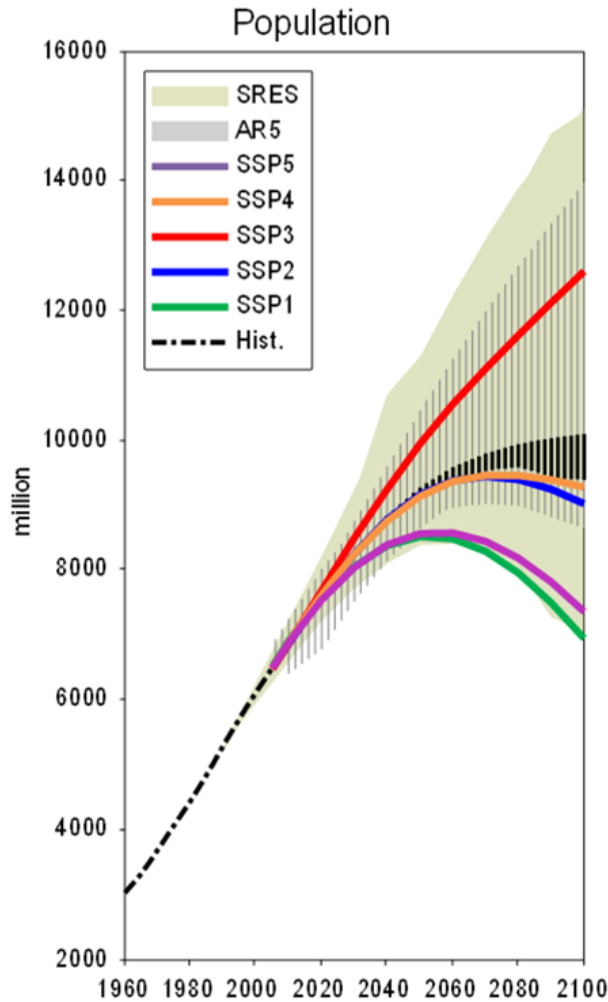
Social, economic, and technological trends proceed along historical patterns

- Development and income growth proceed unevenly
- Slow progress on reaching sustainable development goals
- Technological developments proceed without breakthrough
- Environmental systems experience degradation
- Fossil fuel dependency decreases slowly
 - no reluctance to use unconventional fossil resources
- Moderate population
- Income inequality persists or improves slowly

Illustration of SSP development



Illustrative SSP ranges



New MESSAGE Regions (UNECE Project)

Four new model regions built and calibrated:

1. Central Asian States (CAS): Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

2. Russian Federation (RUS)

3. South Caucasus States (SCS)

Armenia, Azerbaijan, Georgia

4. Ukraine, Belarus, Moldova (UBM)



Map: <https://lib.utexas.edu/>



Collection of Data for the New Regions

Data on population, GDP, and energy resources

Region	Country	Population (2016)	GDP per Capita (\$/yr)	Coal (Mt)	Crude oil (Mt)	Natural gas (bcm)
CAS	Kazakhstan	18 137 300	11 700	148 695	16 963	6098
CAS	Kyrgyzstan	6 140 200	1100	27 499	15	26
CAS	Tajikistan	8 829 300	900	4 075	62	26
CAS	Turkmenistan	5 758 000	7645	800	1782	24 904
CAS	Uzbekistan	32 345 000	1800	10 852	481	3008
RUS	Russia	146 867 905	14 240	2 718 915	48 911	199 818
SCS	Armenia	2 979 600	3500	317	0	10
SCS	Azerbaijan	9 867 250	7500	-	2194	2948
SCS	Georgia	3 718 200	4120	901	56	110
UBM	Belarus	9 495 800	6710	-	57	13
UBM	Moldova	3 550 900	2100	-	10	20
UBM	Ukraine	42 418 235	2459	81 045	354	8074

Data: World Economic Outlook Database, World Bank, BGR, GEA, and USGS

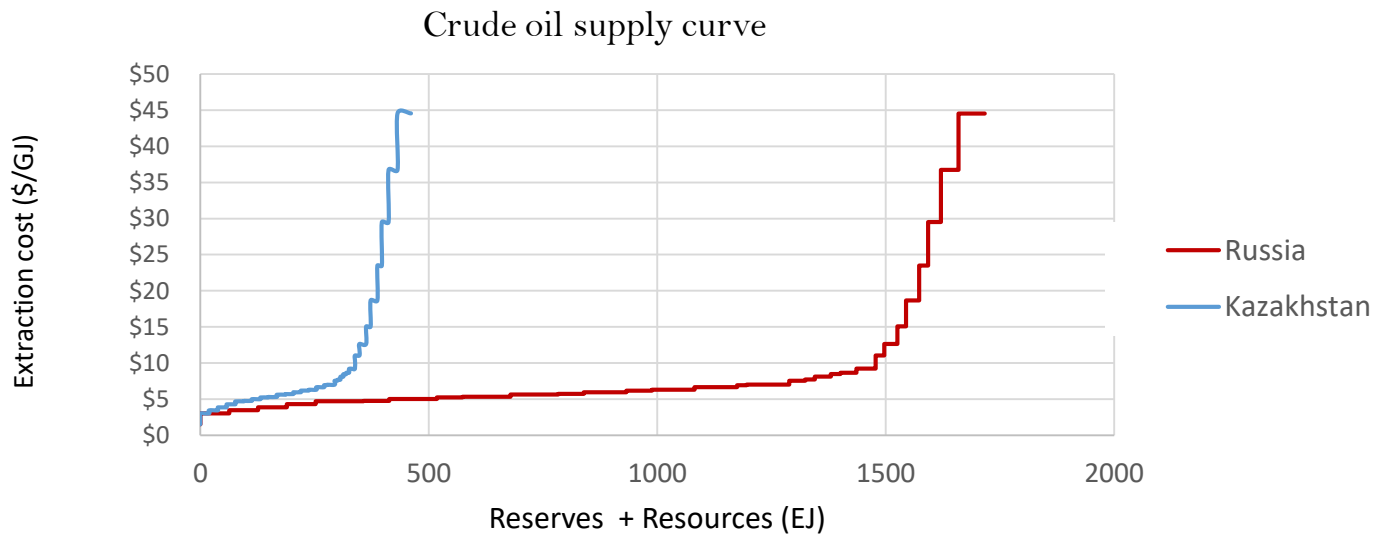


Input Data and Cost Estimations

- Historical **energy balances**: mainly IEA Statistics
- Vintage **capacity** of power plants, cooling technologies, planned capacities: PLATTS, CARMA Database
- **Renewable energy resource potentials** (hydro, biomass, wind and solar): NREL, IMAGE Model
- **Fossil energy resources**:
 - The Federal Inst. for Geosciences and Natural Resources (BGR), DE
 - Undiscovered resources from The US Geological Survey (USGS)
 - IIASA's Global Energy Assessment (GEA) model
- **Cost estimation of technologies over time** (extraction, conversion, transfer, etc.)

Resource cost curves

- Based on the method applied in GEA (Global Energy Assessment)
- Resource cost curves for each country
- Applying SSP2 assumptions about the future of the world



Scenarios

Three Scenarios:

1. Reference Scenario:

a world without no major energy policy (mainly economic drivers)

2. Nationally Determined Contribution 2030 (NDC Scenario)

a policy scenario based on NDCs under Paris Agreement for 2030

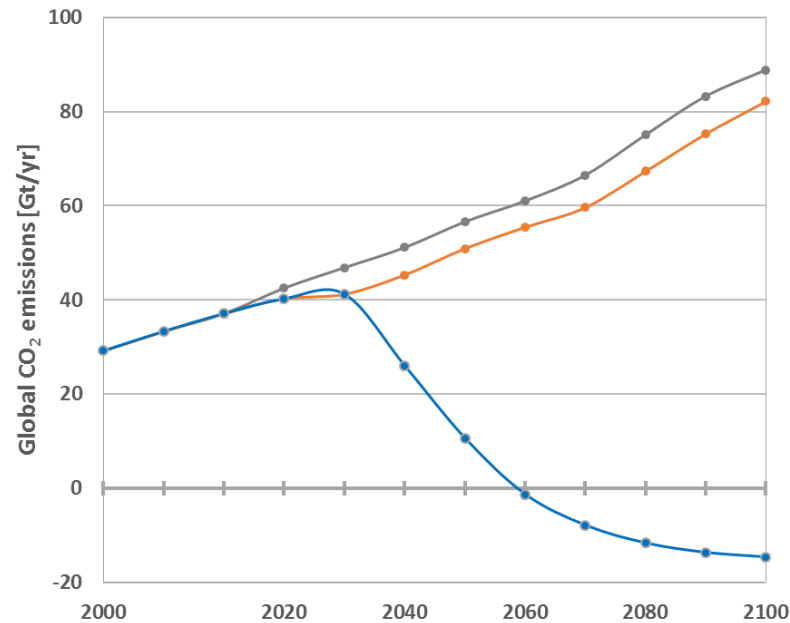
3. Mitigation Scenario (P2C)

policies to mitigate carbon emissions to reach the 2 degree target at the end of the 21st Century

Preliminary Results: Carbon Emissions

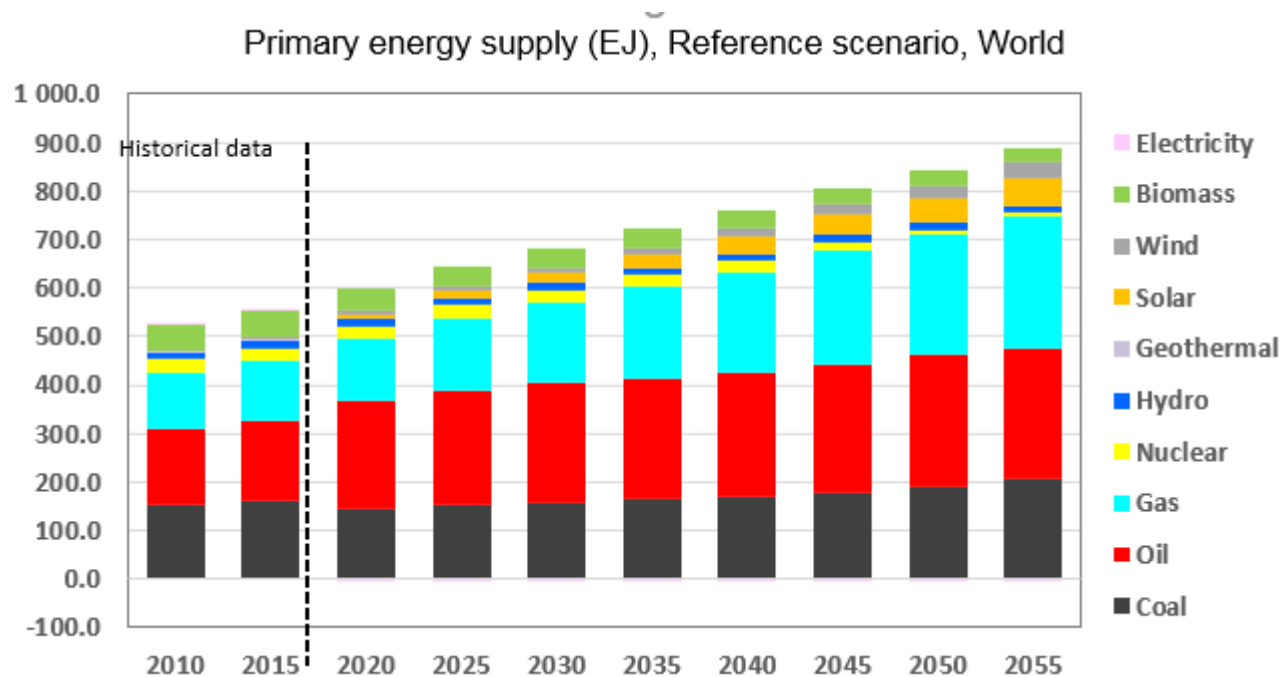
What does mean a 2-degree world?

- Deep decarbonization is needed even after committing to NDCs for 2030



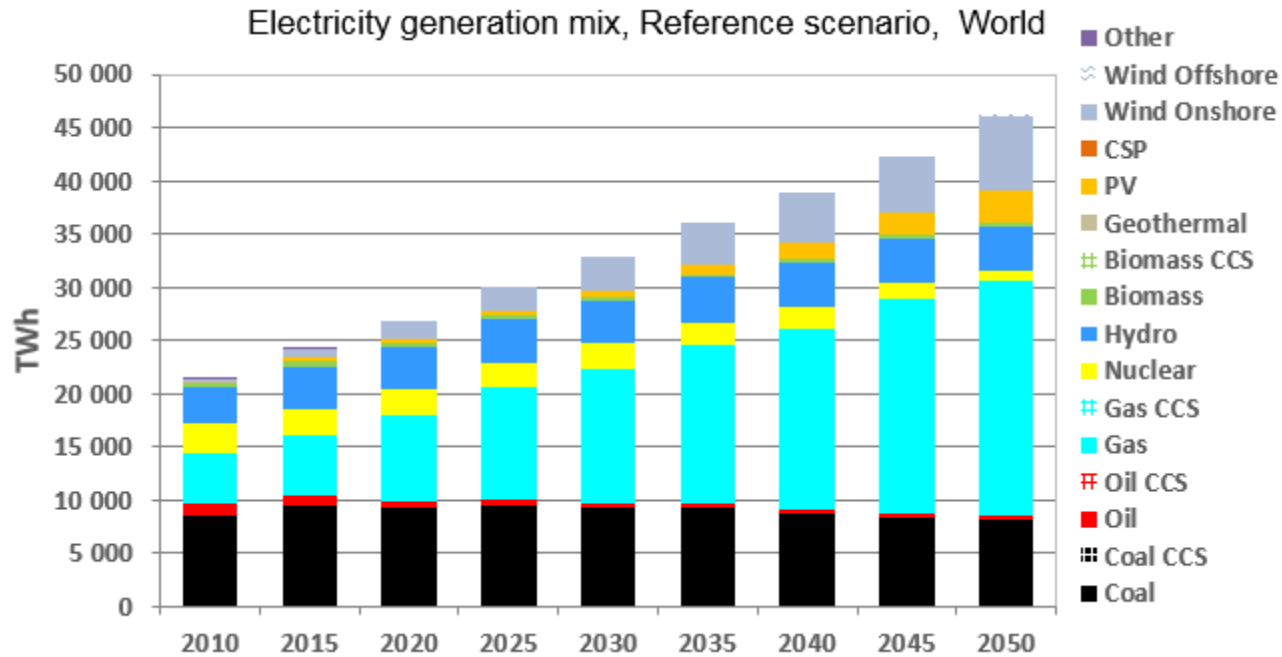
Preliminary Results: Primary Energy

- The World continues using fossil fuels under reference scenario



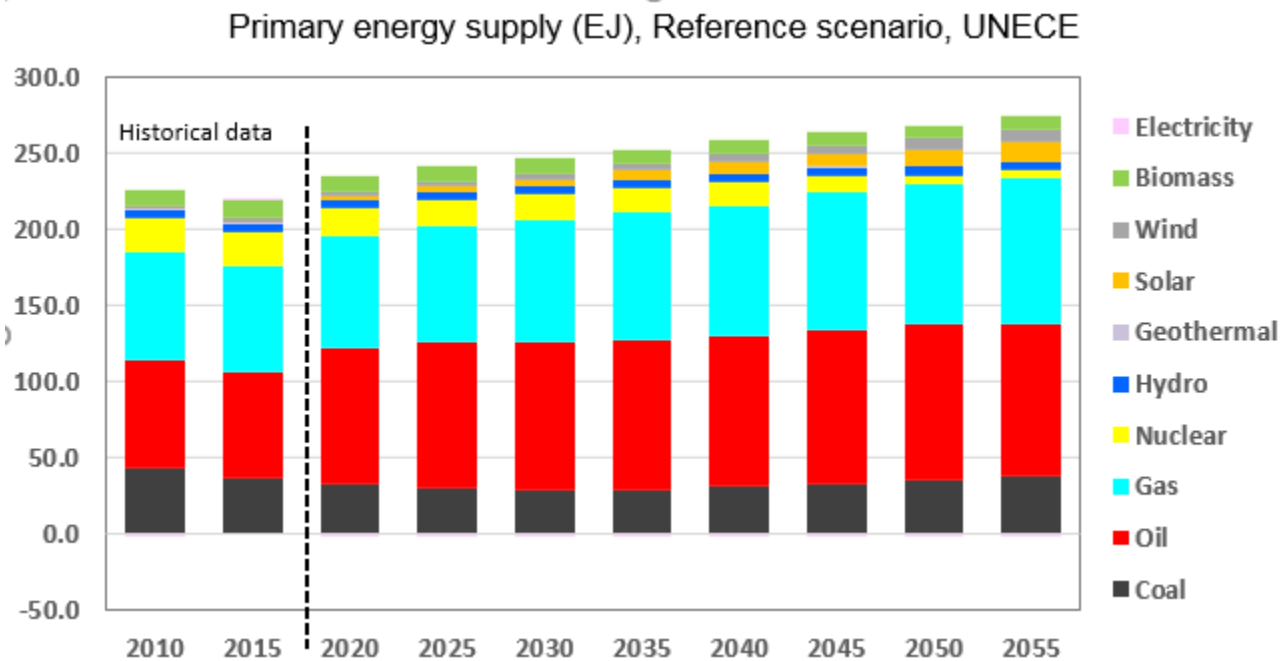
Preliminary Results: Electricity mix

- The World continues using fossil fuels under reference scenario



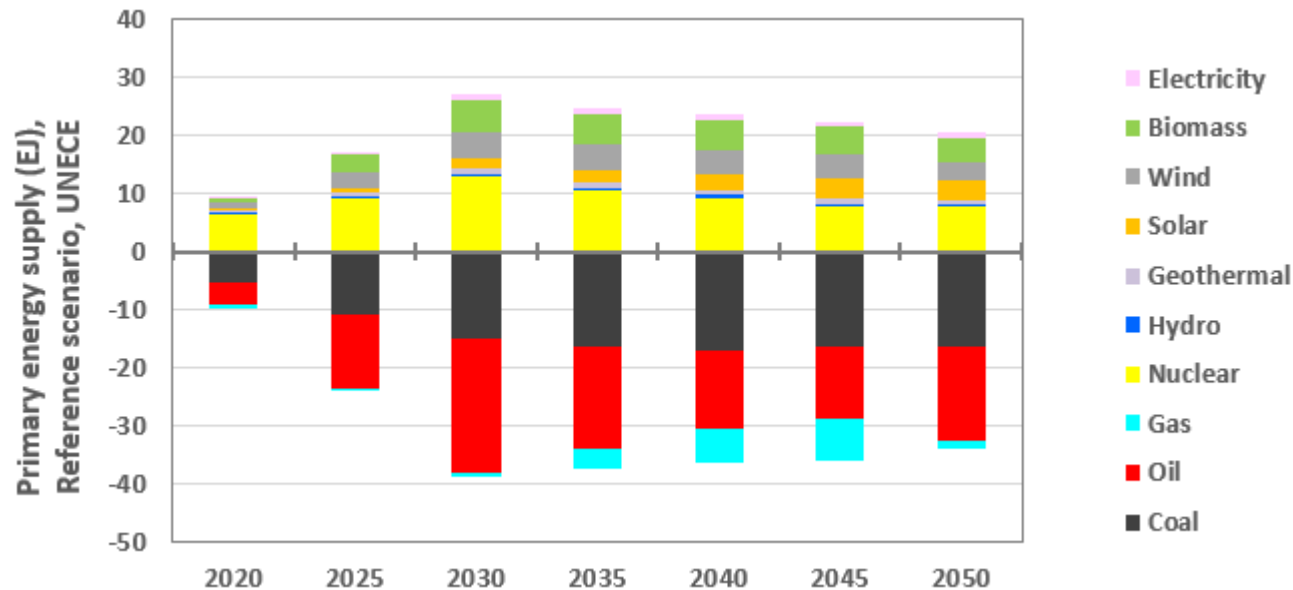
Preliminary Results: Primary Energy

- UNECE region more reliance on gas, and lower consumption growth compared to the rest of the world



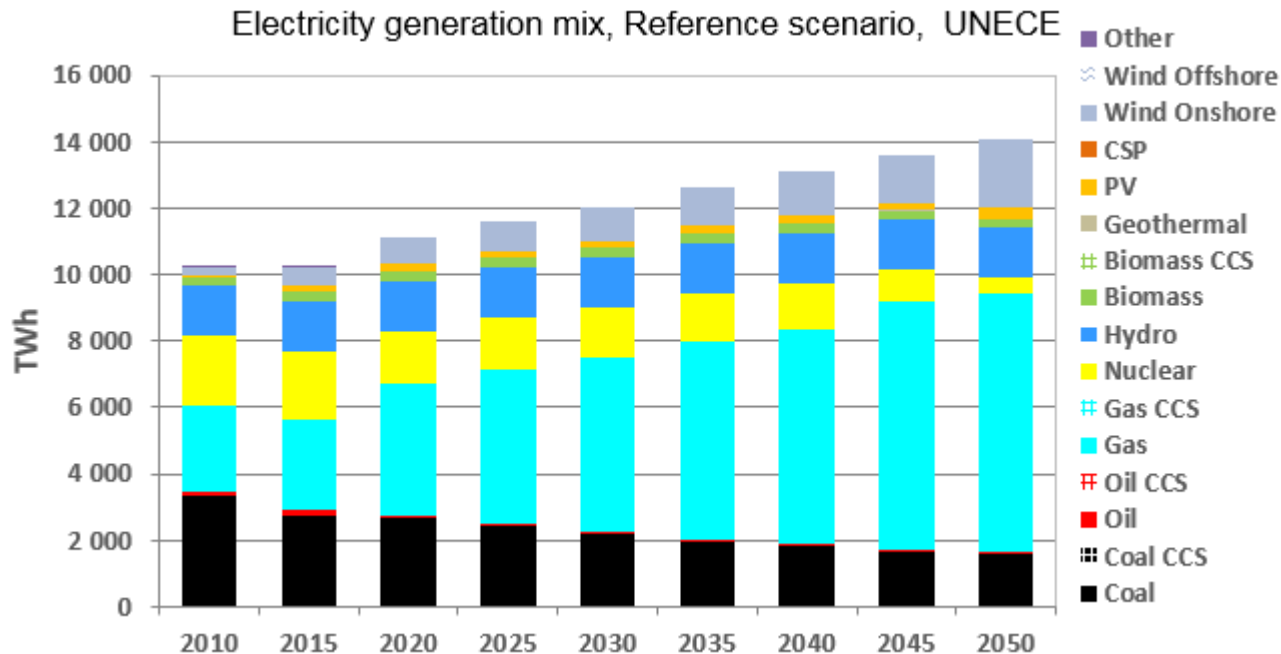
Preliminary Results: Primary Energy

- UNECE region, NDC Scenario 2030 vs. reference scenario: replacement of oil and coal mainly with renewables and nuclear



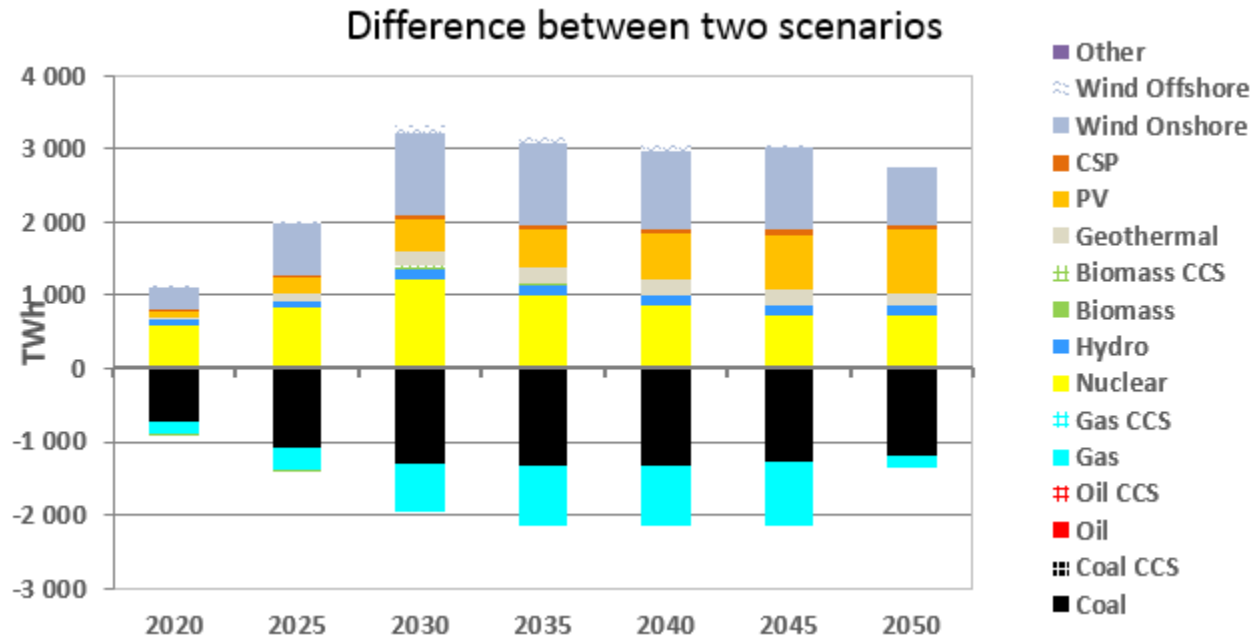
Preliminary Results: Electricity Mix

- Under Reference Scenario: UNECE region reduces coal and nuclear in favor of gas and variable renewables



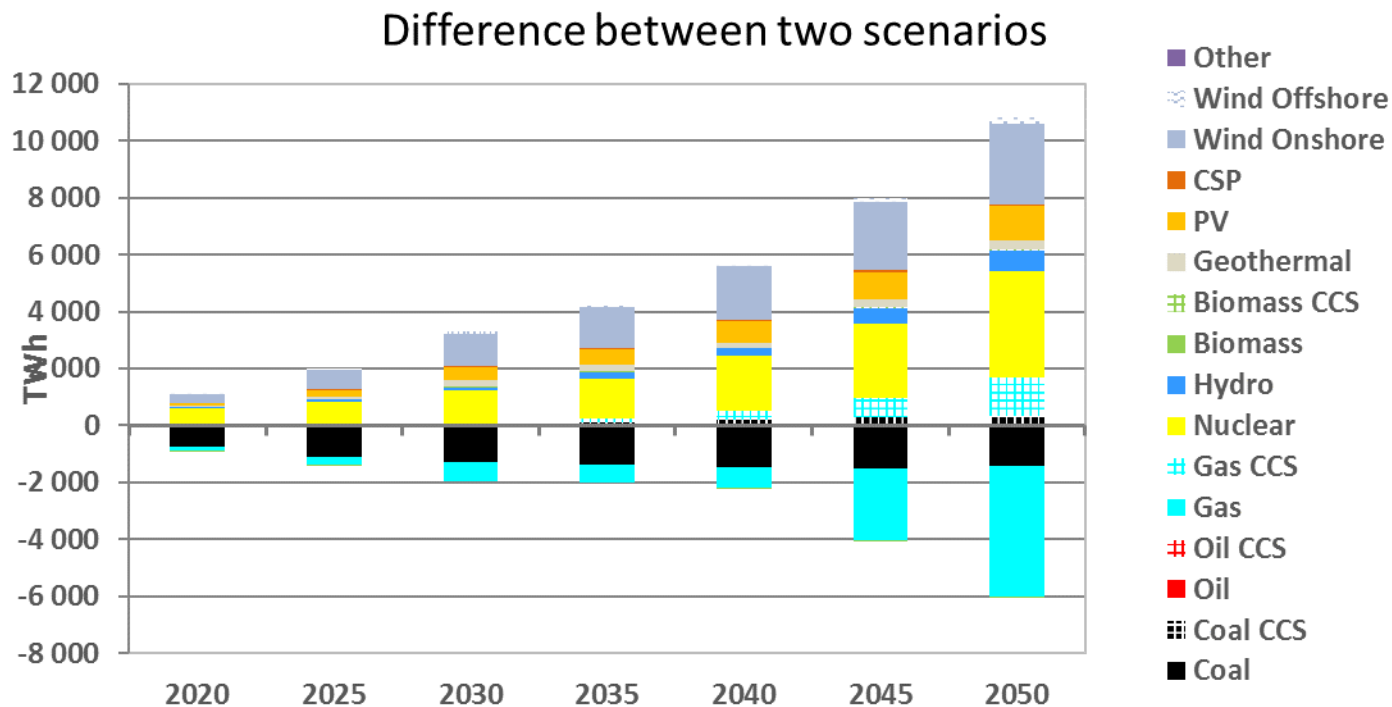
Preliminary Results: Electricity Mix

- NDC 2030 vs. Reference scenario: UNECE region will replace coal and gas mainly with electricity from renewables and nuclear



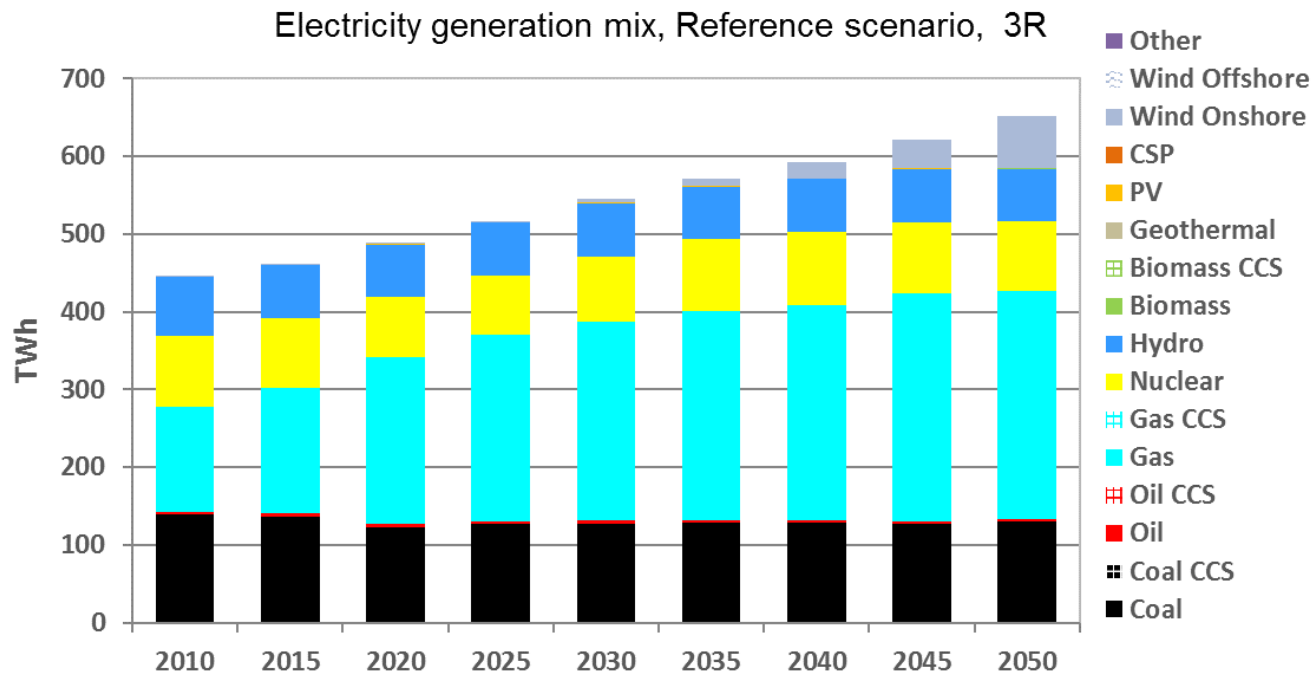
Preliminary Results: Electricity Mix

- P2C vs. Reference scenario: UNECE region will replace coal and gas mainly with electricity from renewables and nuclear



Preliminary Results: Electricity Mix

- Reference scenario: Central Asia, Caucasus, BMU= (3R)



Motivation

Disaggregation

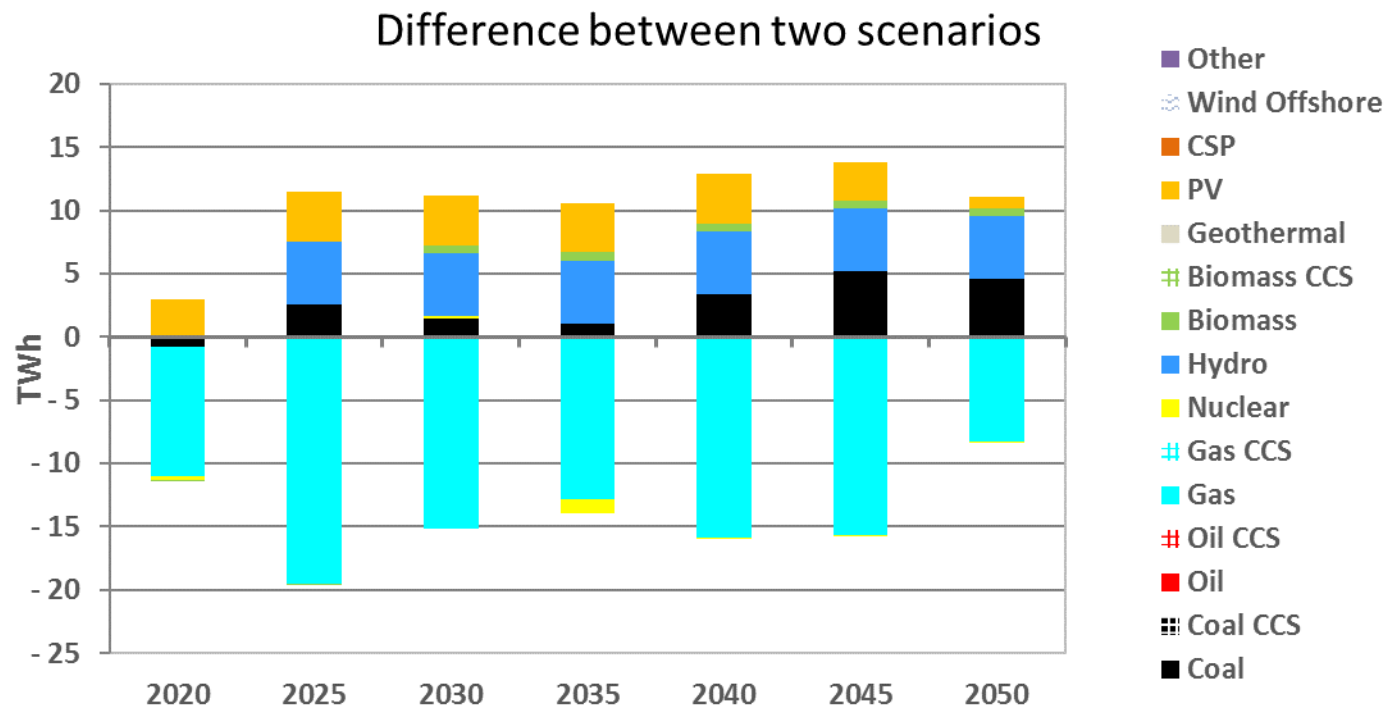
Resource assessment

Results

Final Notes

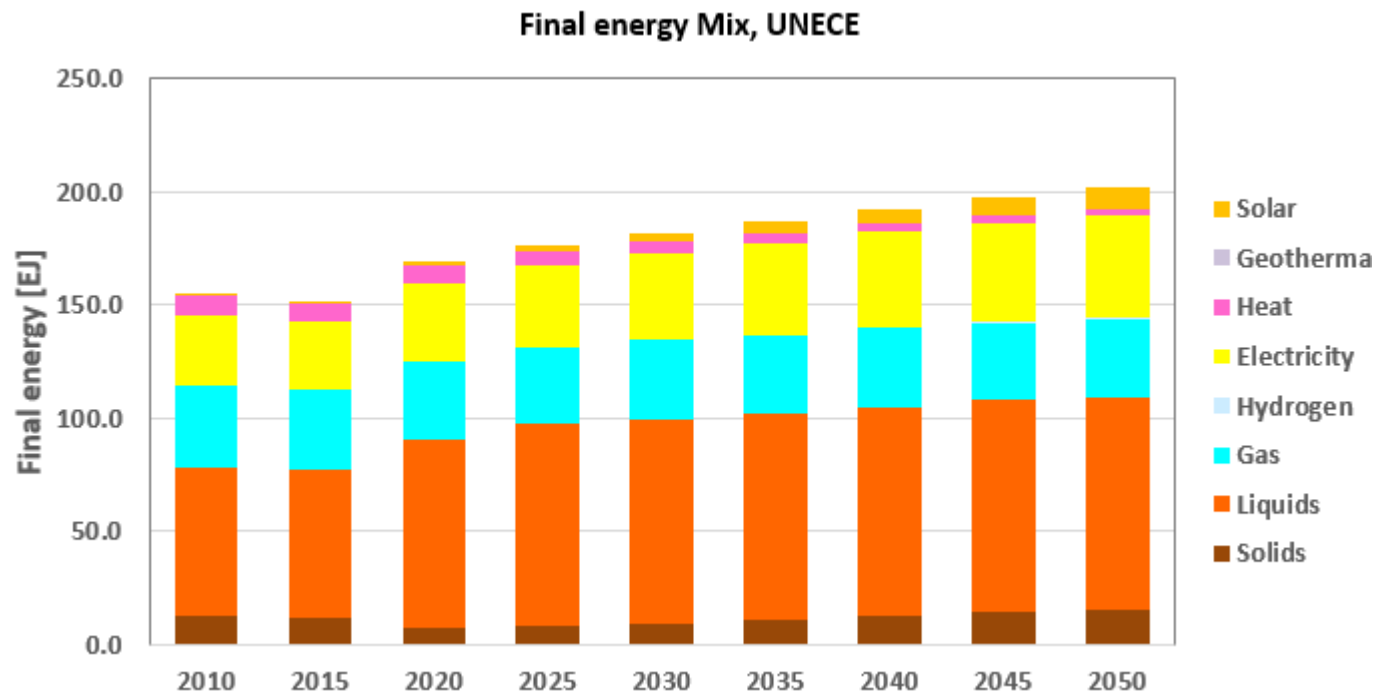
Preliminary Results: Electricity Mix

- NDC vs. Reference scenario: Most of the regions have already met their climate targets



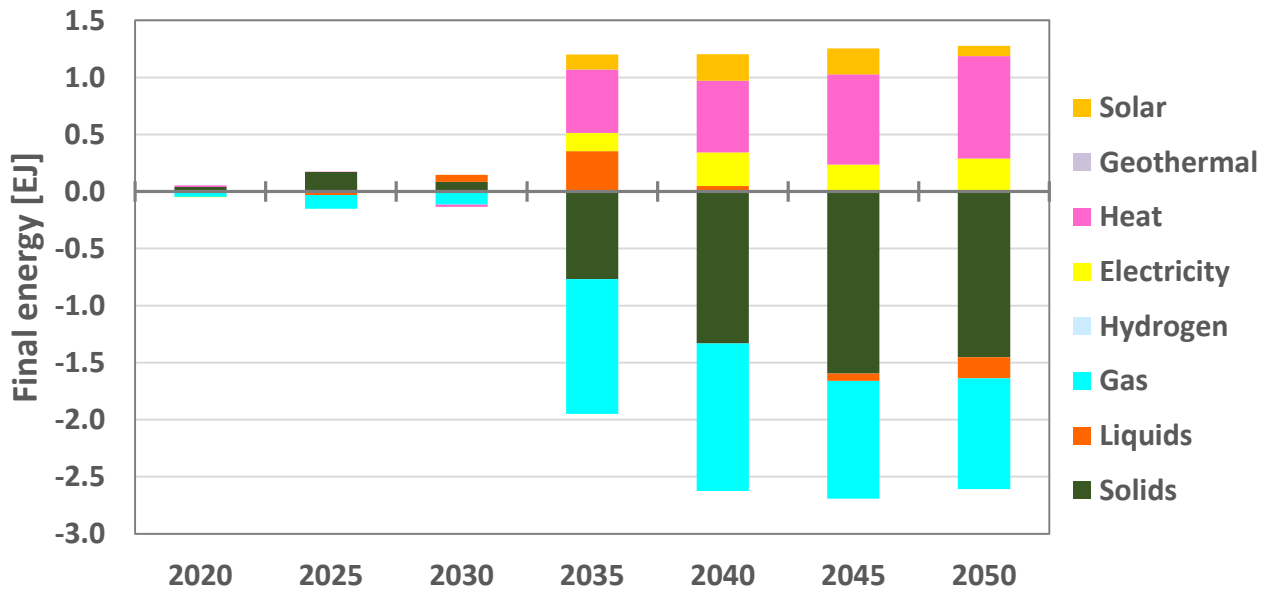
Preliminary Results: Final Energy Consumption

- UNECE region increasing the use of liquids under Reference scenario



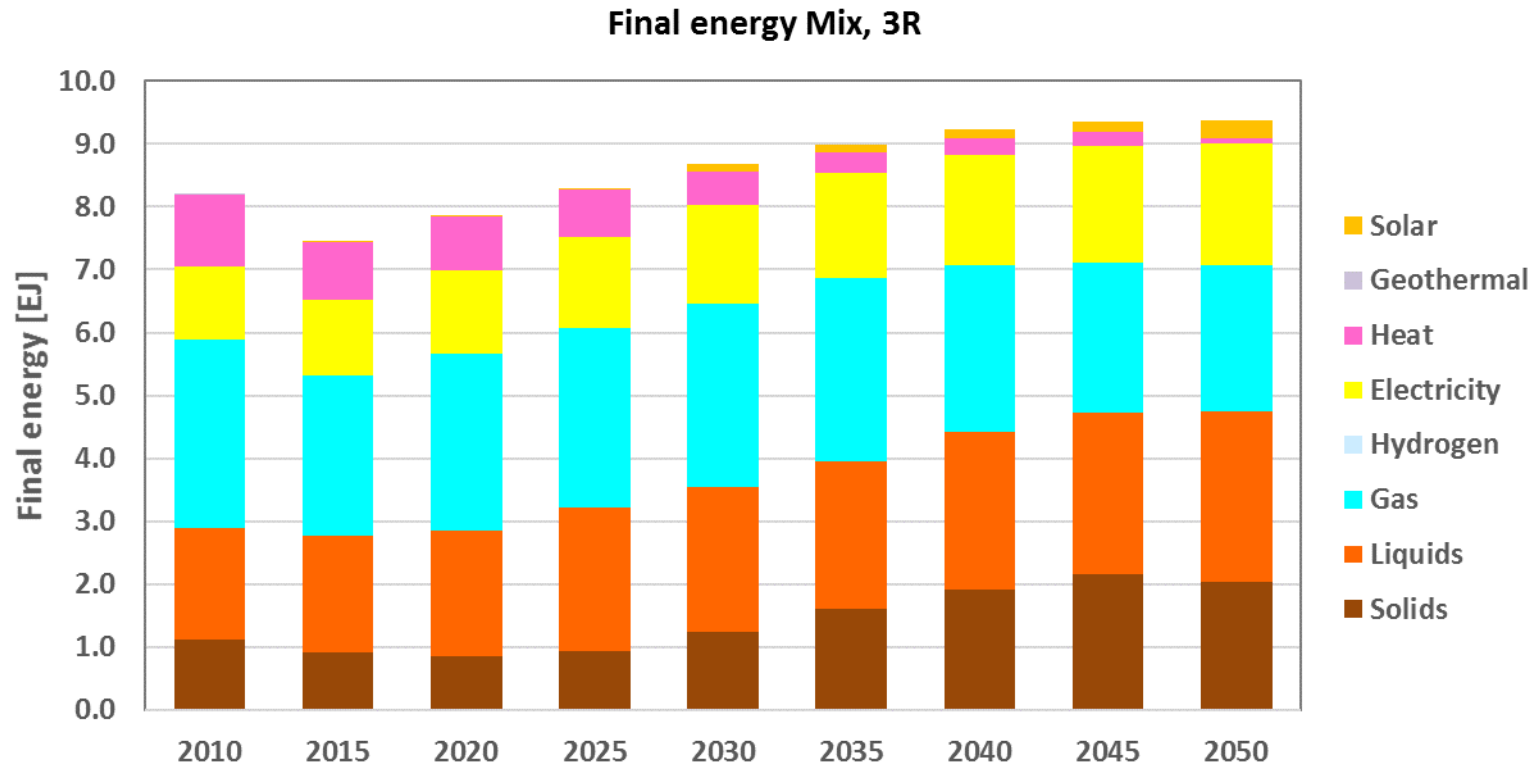
Preliminary Results: Final Energy Consumption

- UNECE region will advocate further electrification under NDC scenario



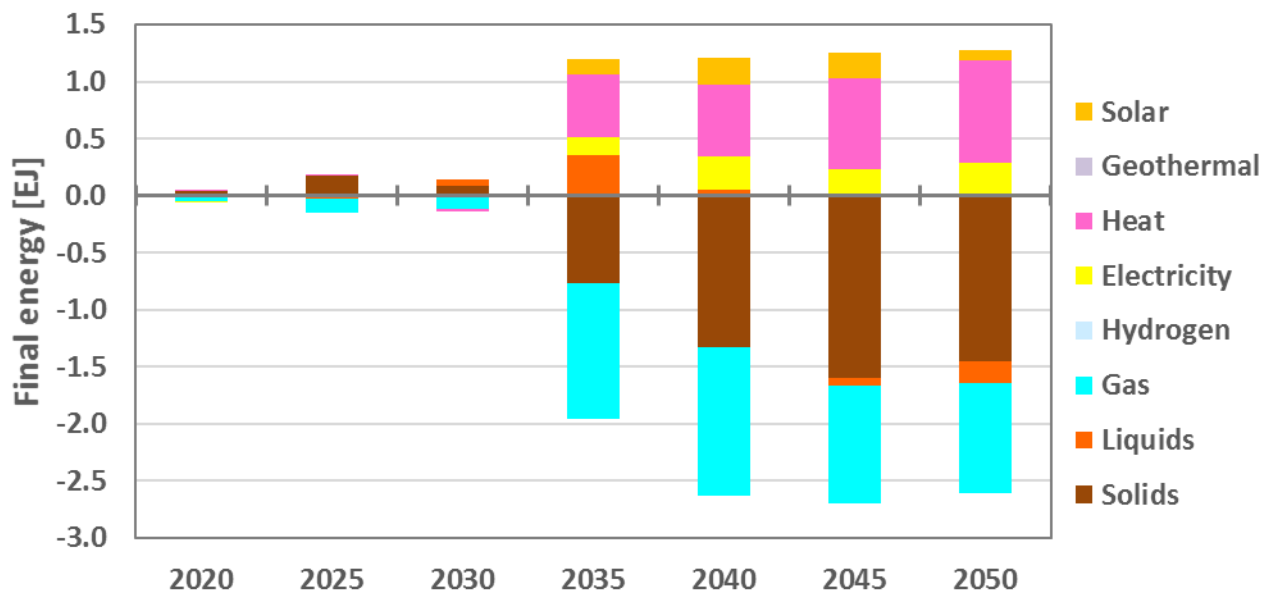
Preliminary Results: Final Energy Consumption

- Central Asia reduces district heating in favor of liquid fuels over time



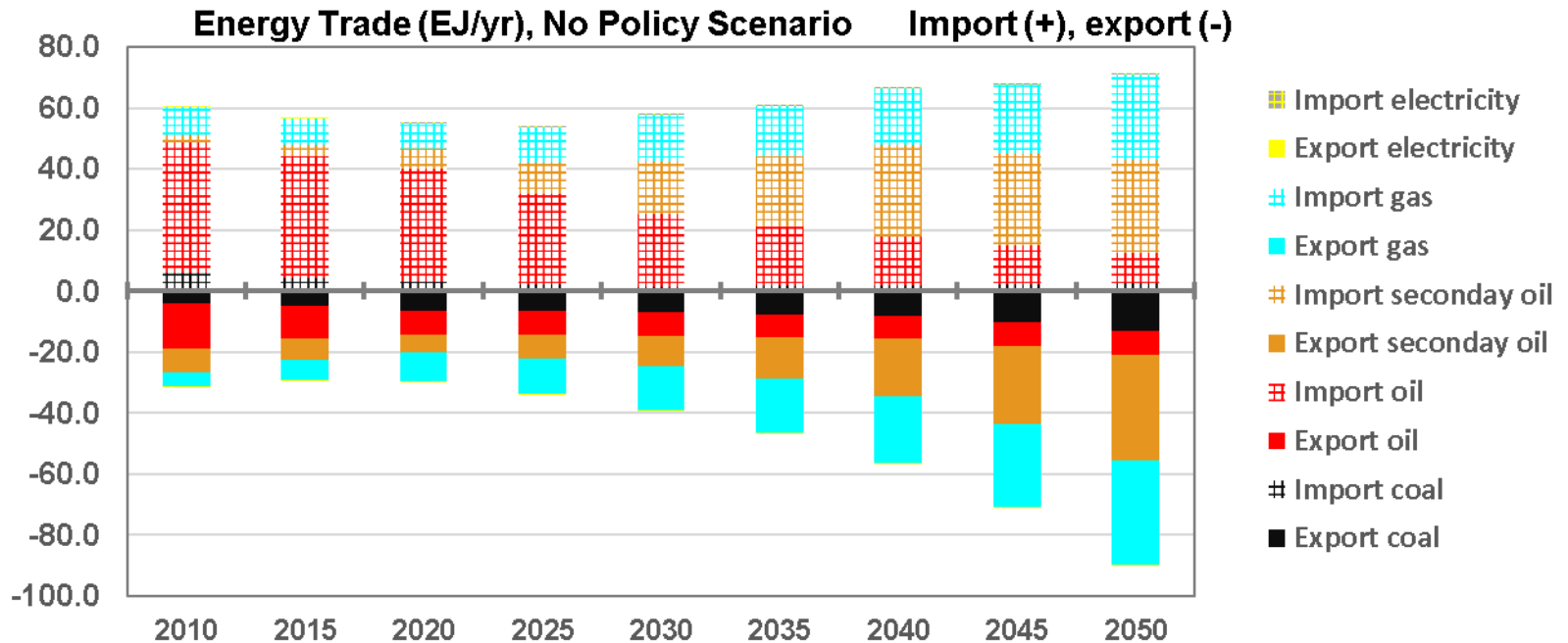
Preliminary Results: Final Energy Consumption

- 3R will replace liquids and solid fuels with electricity under NDC scenario



Preliminary Results: Energy Trade

- UNECE would continue to increase the net energy exports to the rest of the world if No Policy in place



Final note

- The difference between reference and NDC scenario in some regions is not significant as those countries have very lenient targets
- The accurate representation of energy trade shows the implications of different scenarios for the trade between UNECE regions and the rest of the world
- The shift towards electrification and decentralized systems under NDC scenarios are evident
- The preliminary results of 2-degree shows a shift towards nuclear, VRE and CCS technologies in UNECE

Thank you for the attention!

Motivation

Disaggregation

Resource assessment

Results

Final Notes