

# Shell Scenarios **Sky**

How Turkey could reach net-zero emissions

**David Hone**, Chief Climate Change Advisor, Shell International Ltd.

# WARNING: Uncertainties ahead

This presentation contains data from Shell's new Sky Scenario. Unlike Shell's previously published Mountains and Oceans exploratory scenarios, the Sky Scenario is targeted through the assumption that society reaches the Paris Agreement's goal of holding global average temperatures to well below 2°C. Unlike Shell's Mountains and Oceans scenarios which unfolded in an open-ended way based upon plausible assumptions and quantifications, the Sky Scenario was specifically designed to reach the Paris Agreement's goal in a technically possible manner. These scenarios are a part of an ongoing process used in Shell for over 40 years to challenge executives' perspectives on the future business environment. They are designed to stretch management to consider even events that may only be remotely possible. Scenarios, therefore, are not intended to be predictions of likely future events or outcomes and investors should not rely on them when making an investment decision with regard to Royal Dutch Shell plc securities.

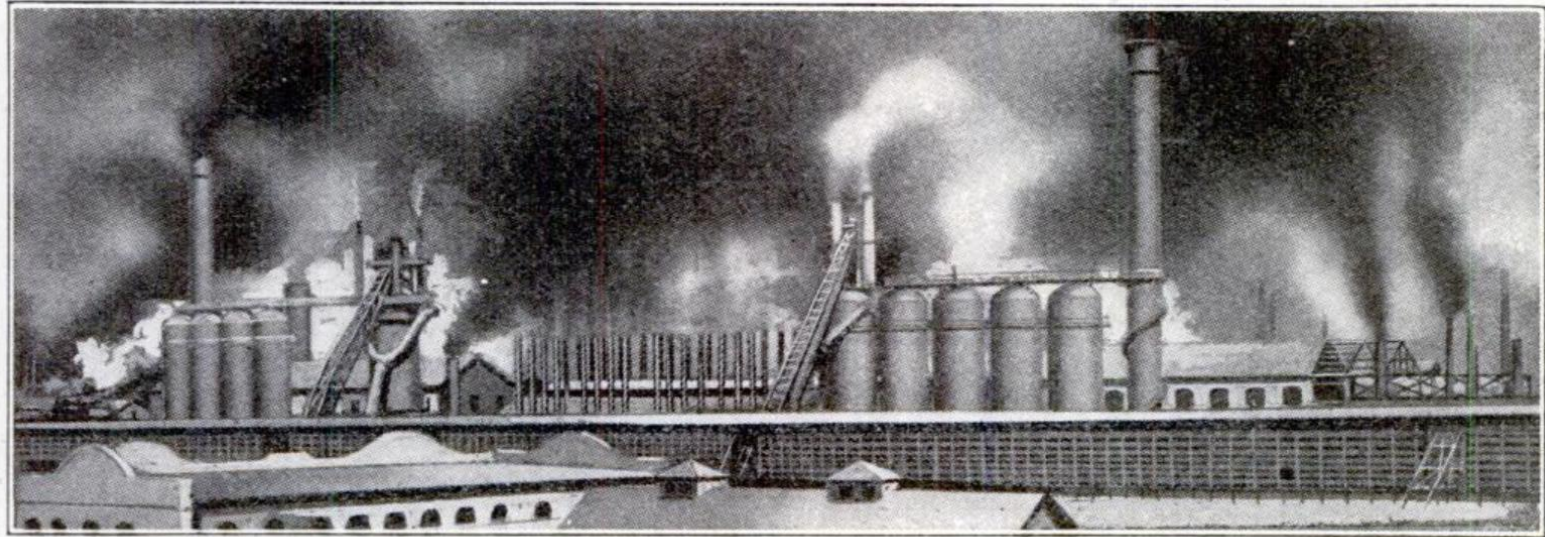
Additionally, it is important to note that Shell's existing portfolio has been decades in development. While we believe our portfolio is resilient under a wide range of outlooks, including the IEA's 450 scenario (World Energy Outlook 2016), it includes assets across a spectrum of energy intensities including some with above-average intensity. While we seek to enhance our operations' average energy intensity through both the development of new projects and divestments, we have no immediate plans to move to a net-zero emissions portfolio over our investment horizon of 10-20 years. Although, we have no immediate plans to move to a net-zero emissions portfolio, in November of 2017, we announced our ambition to reduce our net carbon footprint in accordance with society's implementation of the Paris Agreement's goal of holding global average temperature to well below 2°C above pre-industrial levels. Accordingly, assuming society aligns itself with the Paris Agreement's goals, we aim to reduce our net carbon footprint, which includes not only our direct and indirect carbon emissions, associated with producing the energy products which we sell, but also our customers' emissions from their use of the energy products that we sell, by 20% in 2035 and by 50% in 2050.

The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this presentation "Shell", "Shell group" and "Royal Dutch Shell" are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to subsidiaries in general or to those who work for them. These expressions are also used where no useful purpose is served by identifying the particular company or companies. "Subsidiaries", "Shell subsidiaries" and "Shell companies" as used in this presentation refer to companies over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations" respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in a venture, partnership or company, after exclusion of all third-party interest.

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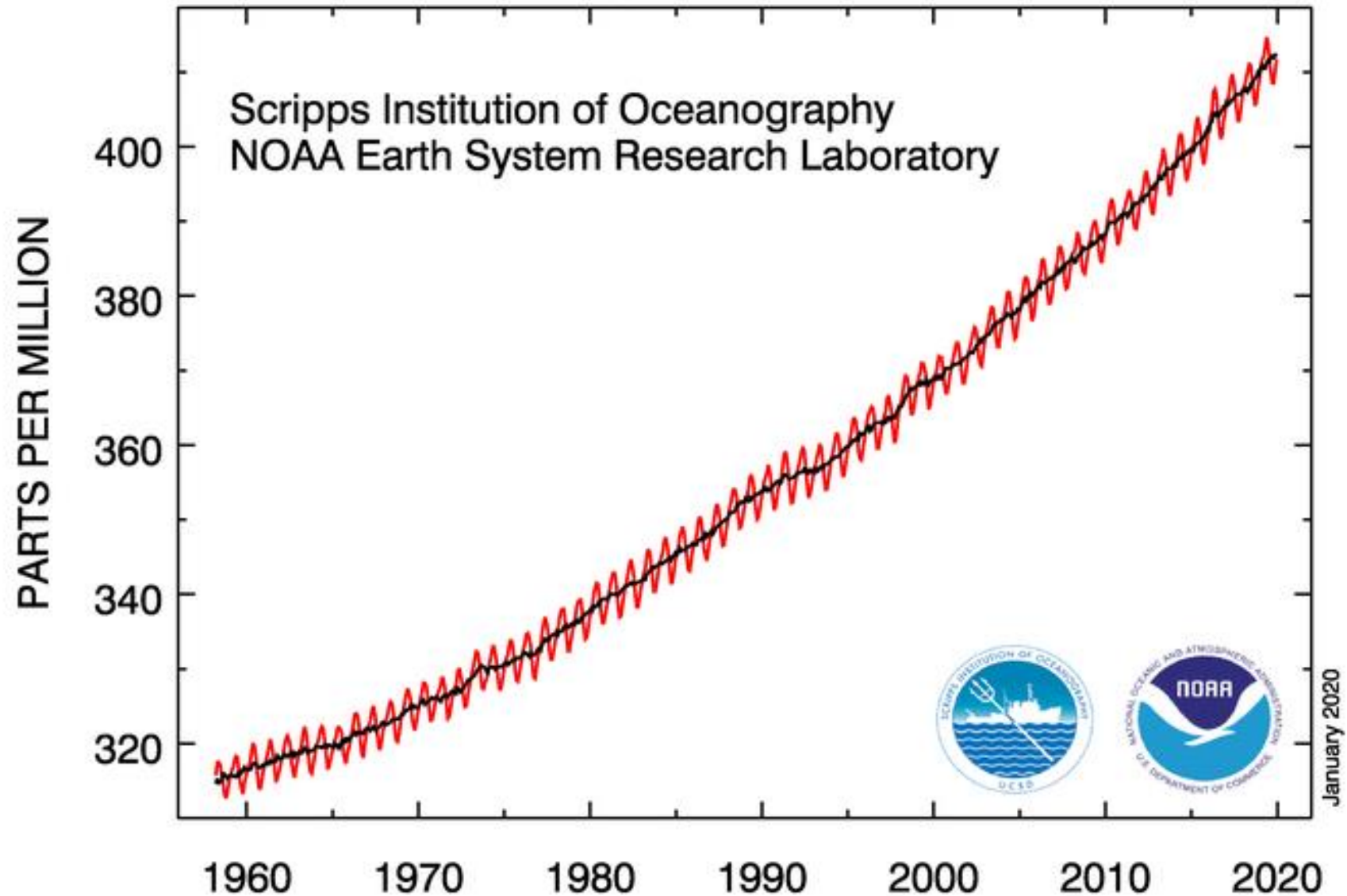


Back in 1912 . . . . .

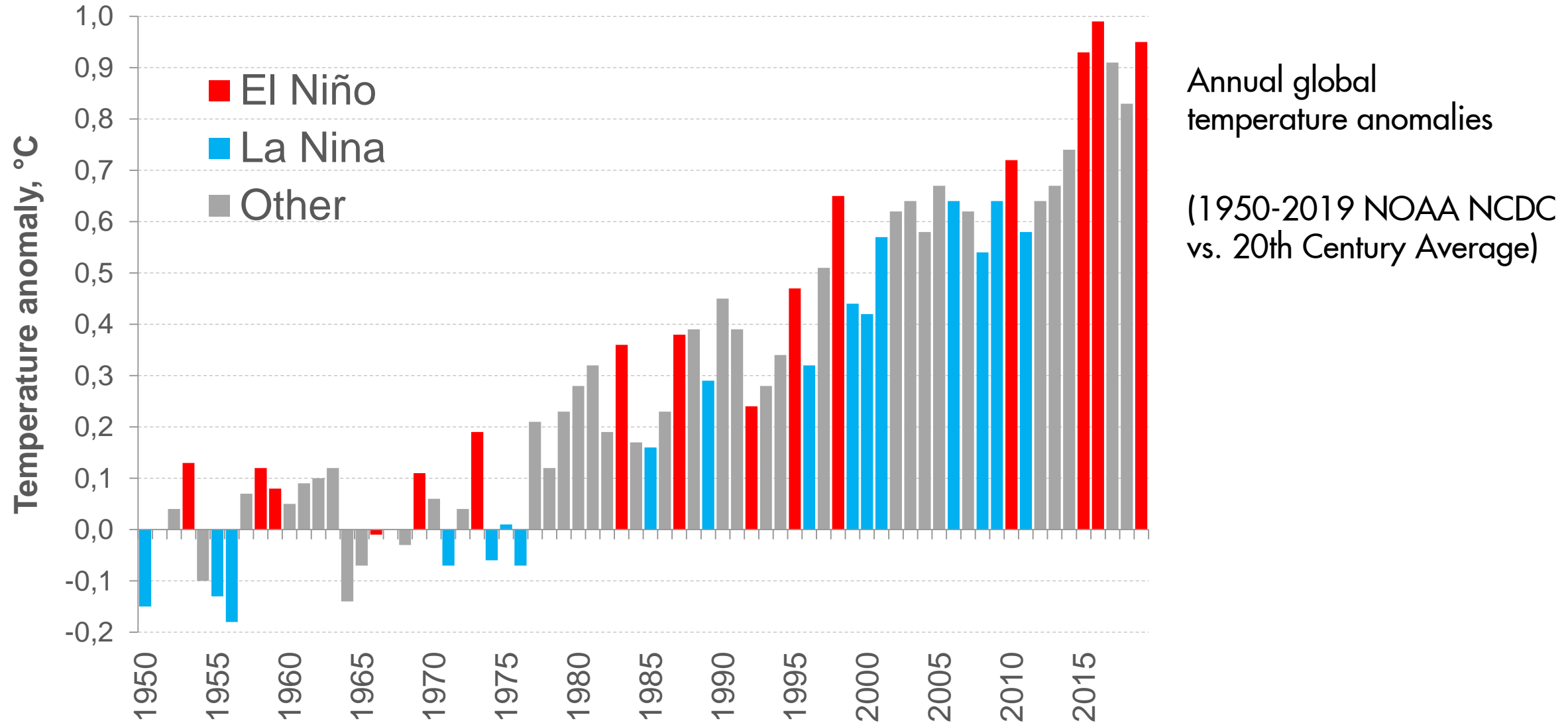


The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.

# Atmospheric CO<sub>2</sub> record at Mauna Loa Observatory

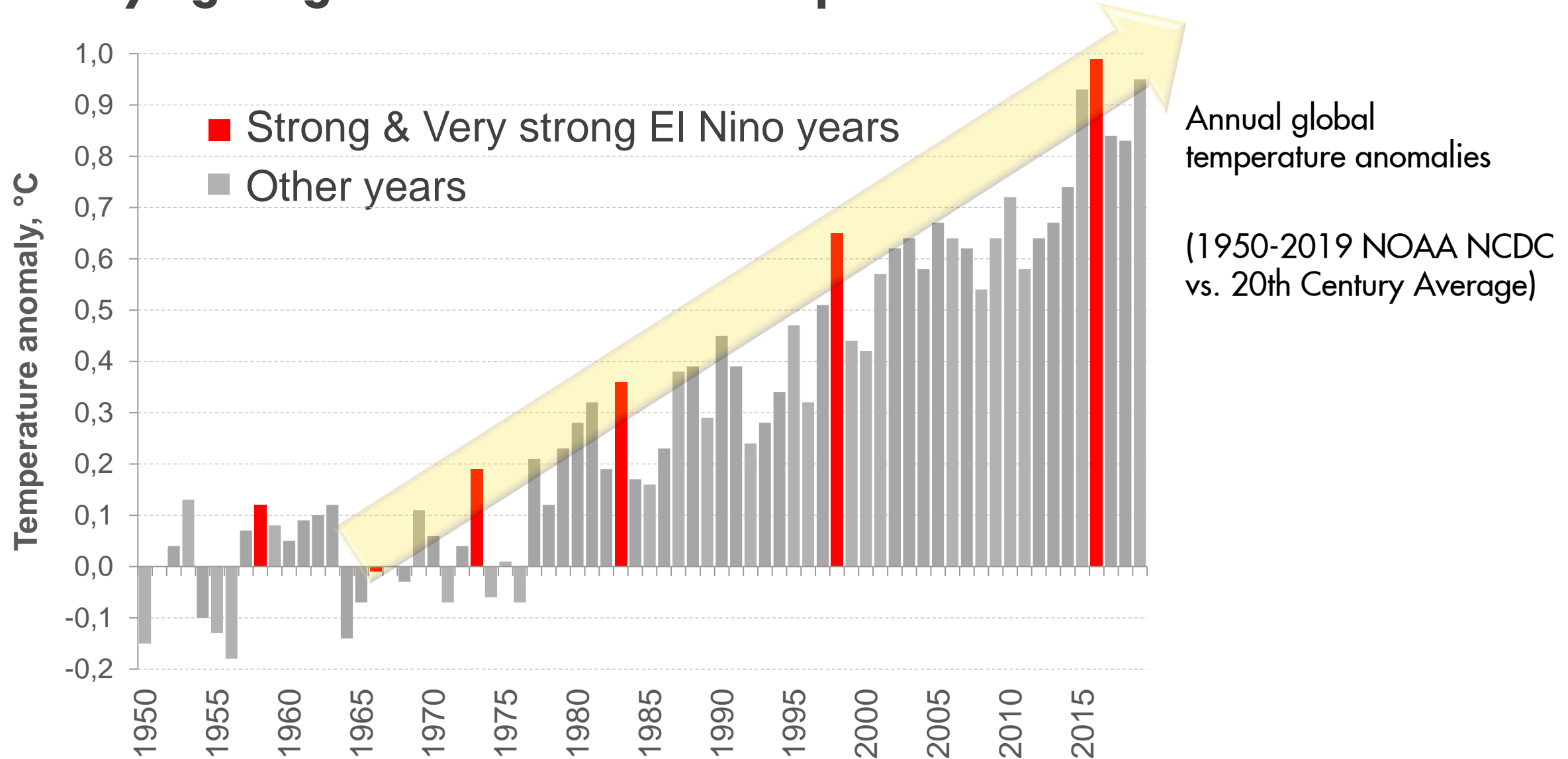


# 2019: A very weak El Niño brings the second warmest year

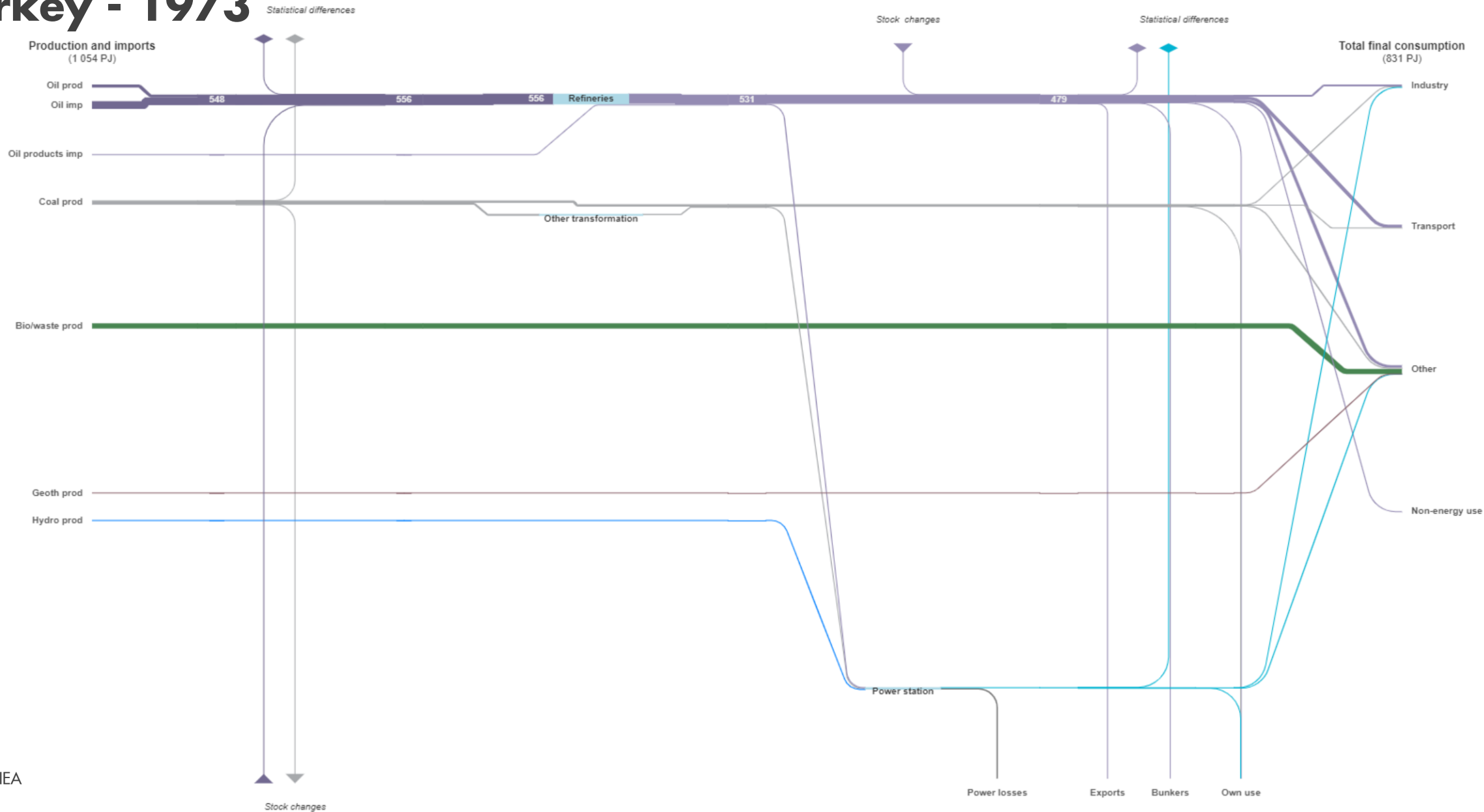




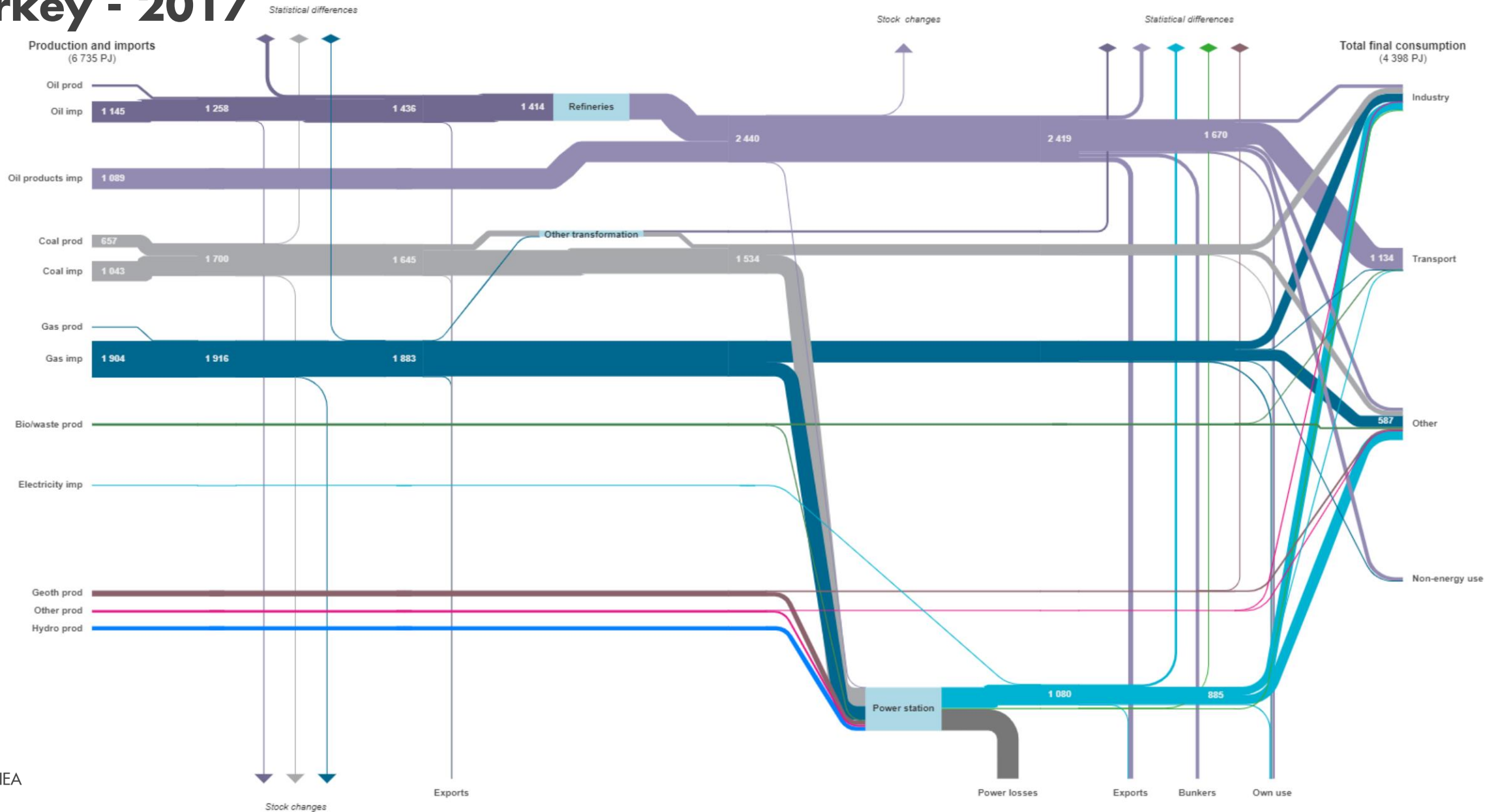
## A worrying long term trend of $\sim 0.2^{\circ}\text{C}$ per decade



# Turkey - 1973

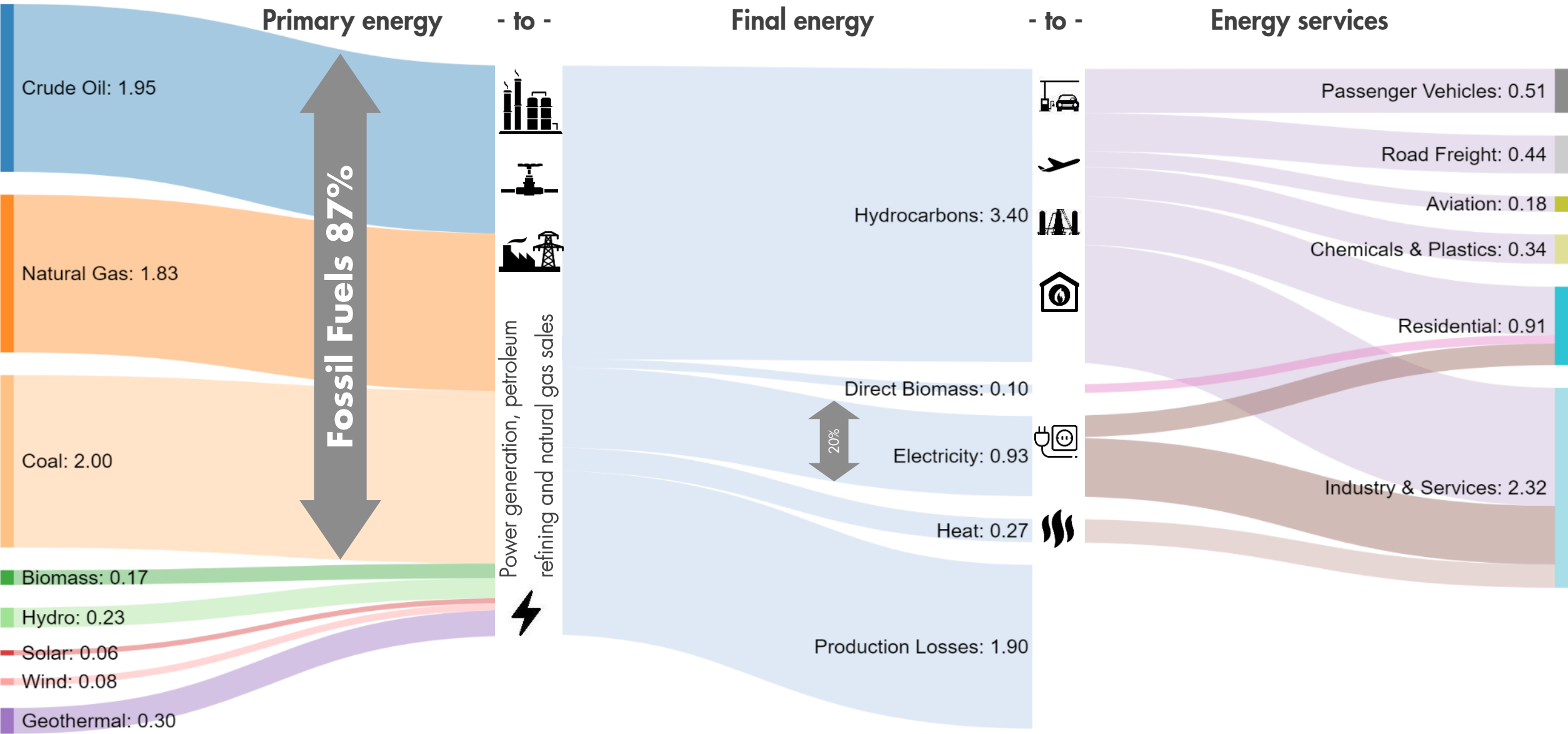


# Turkey - 2017





# Turkey energy system services (Sky, 2020, 7 EJ primary energy)

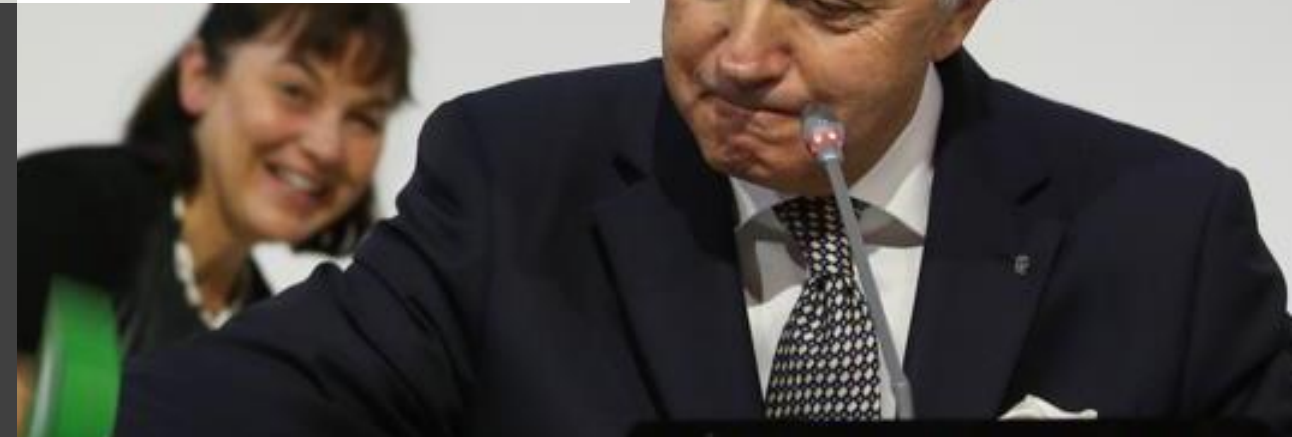


# The goals of the Paris Agreement



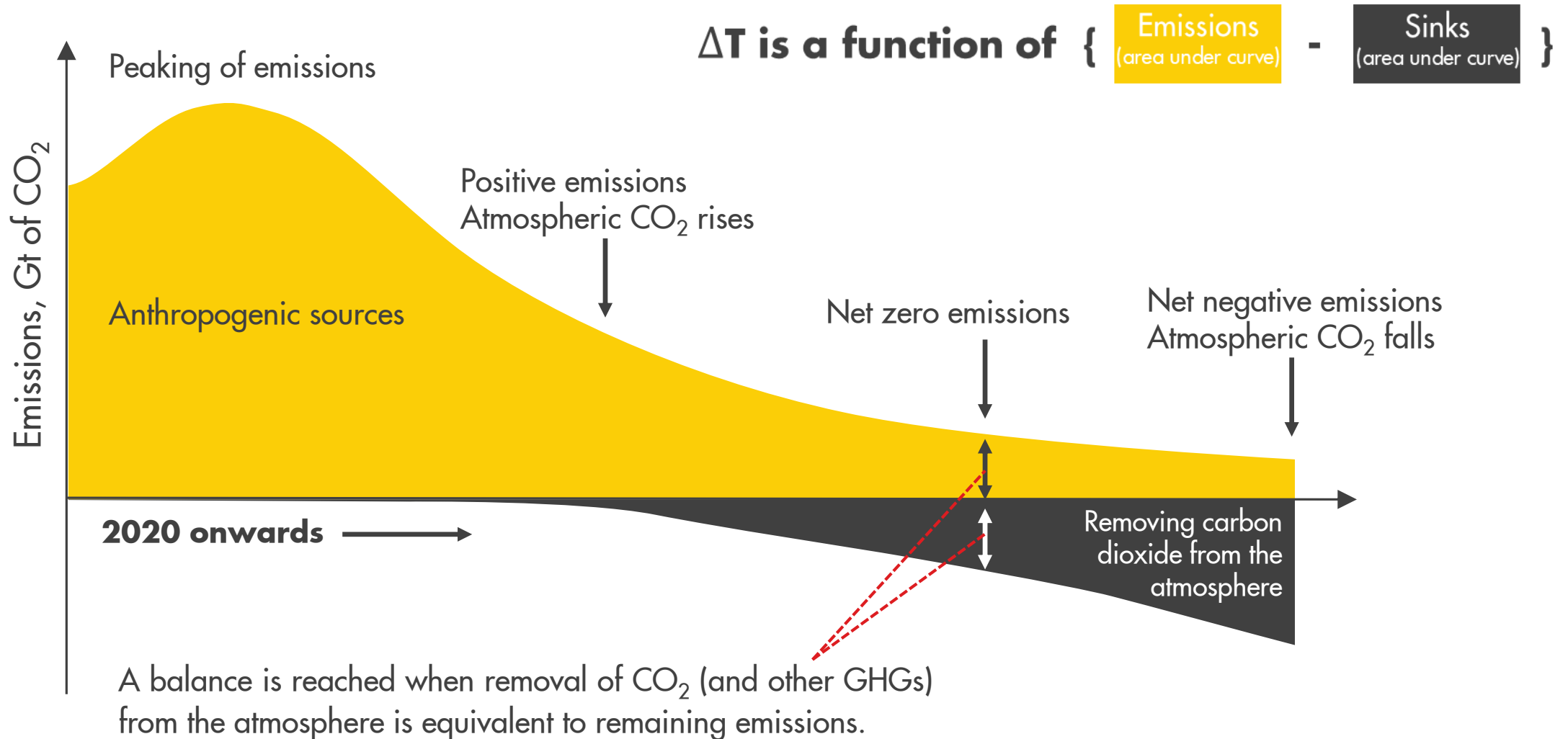
...aim to reach global peaking of greenhouse gas emissions as soon as possible;

Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels



...achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century.

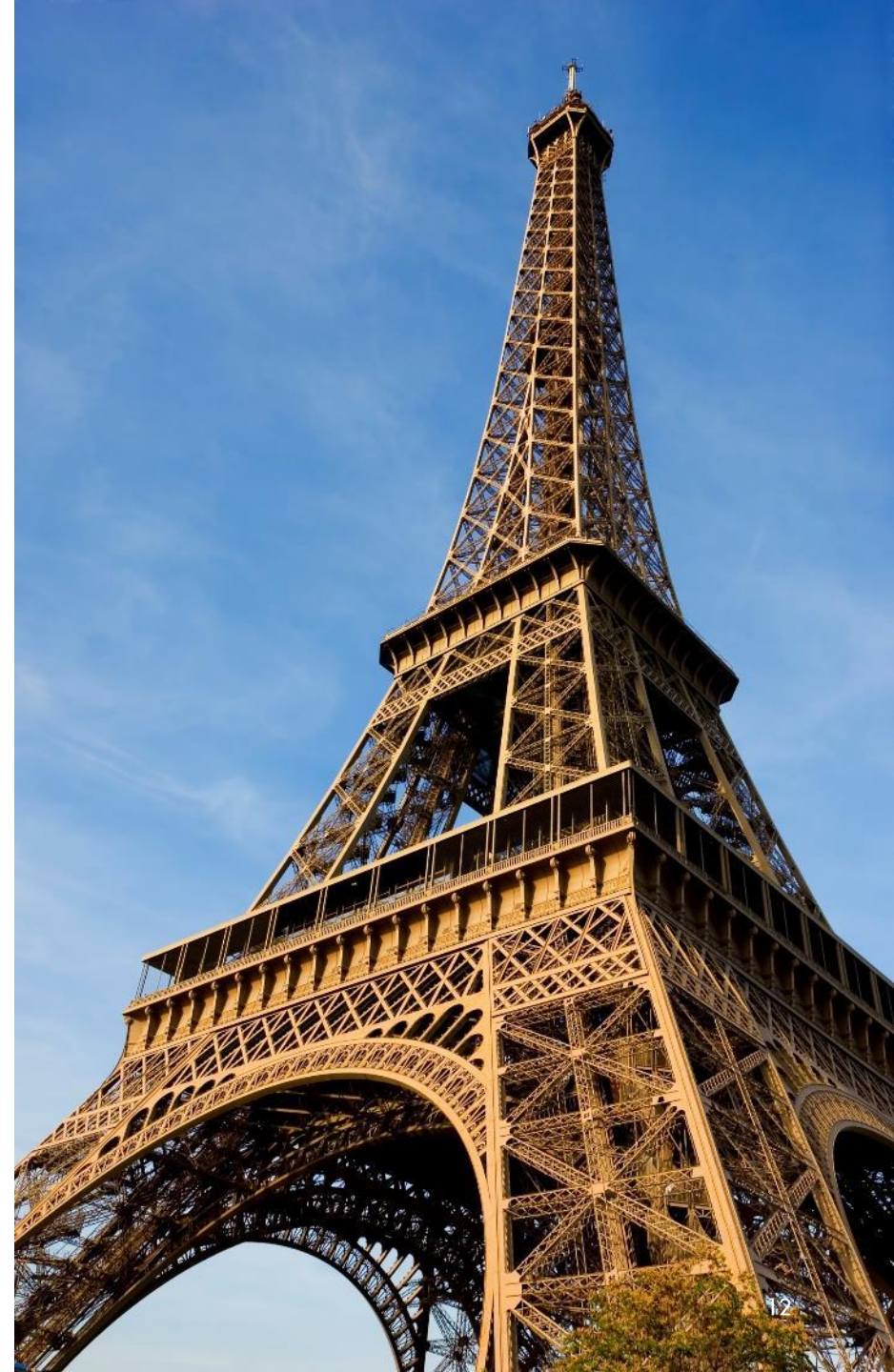
# Elements of the Paris Agreement





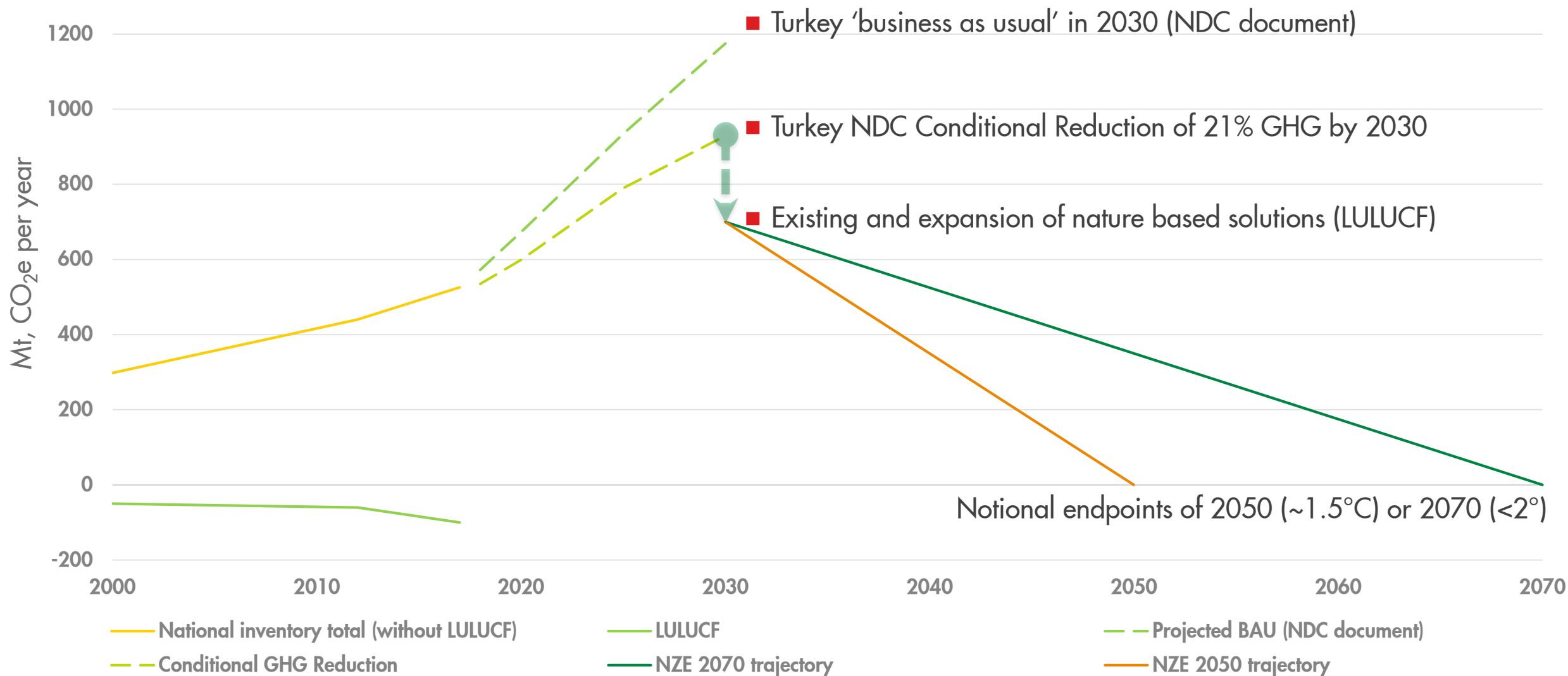
# The Paris Agreement –

review, assess and improve by countries

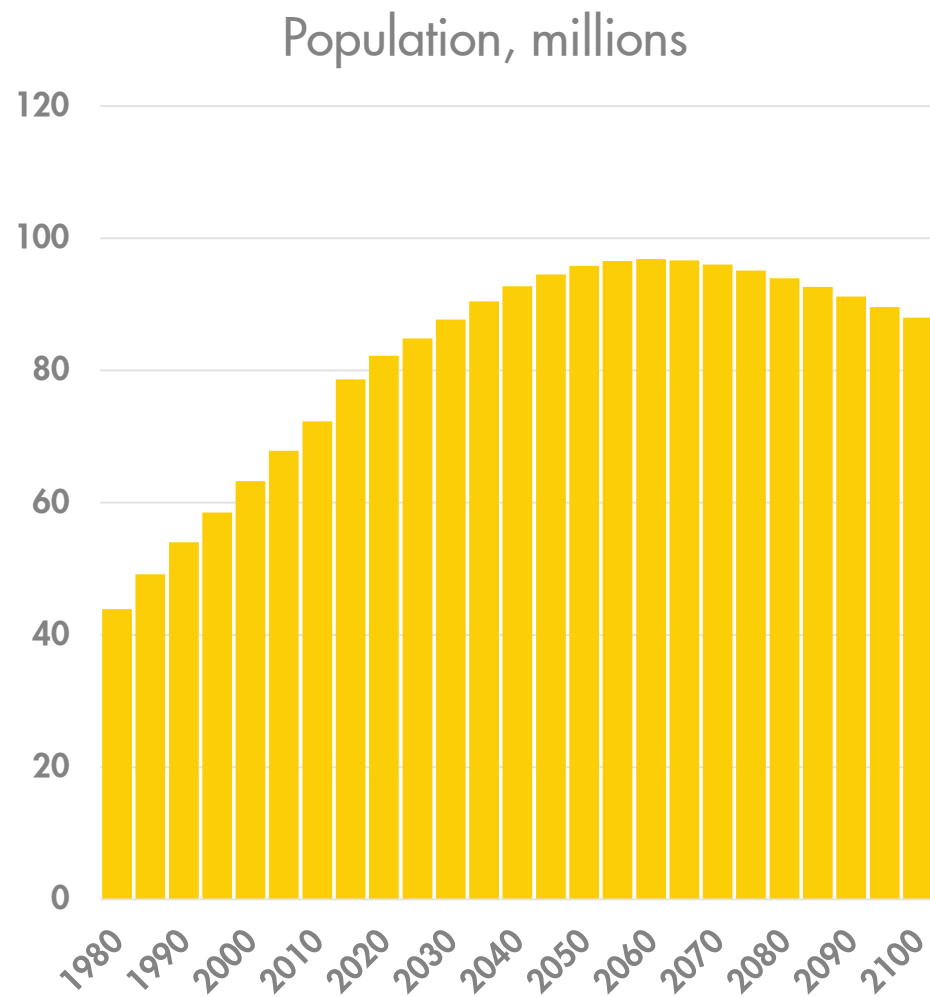




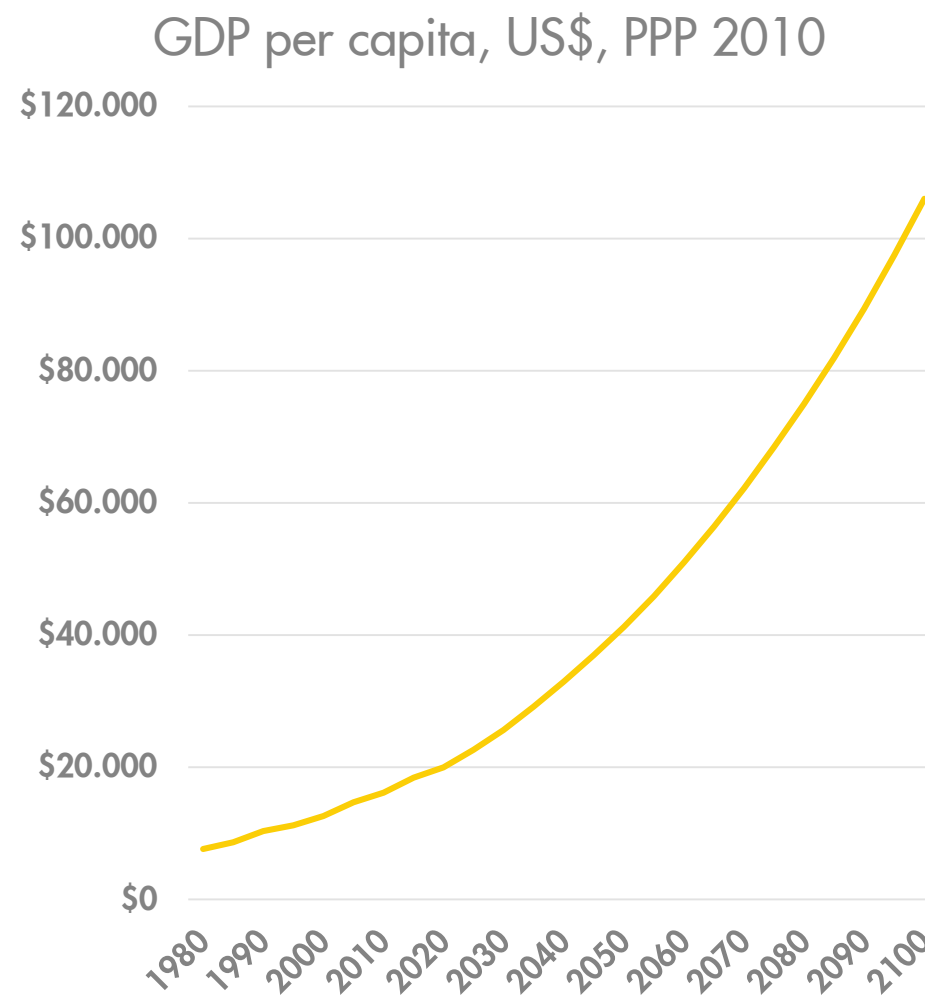
# Turkey greenhouse gas emissions progress and NDC projections



# Turkey Basic Data

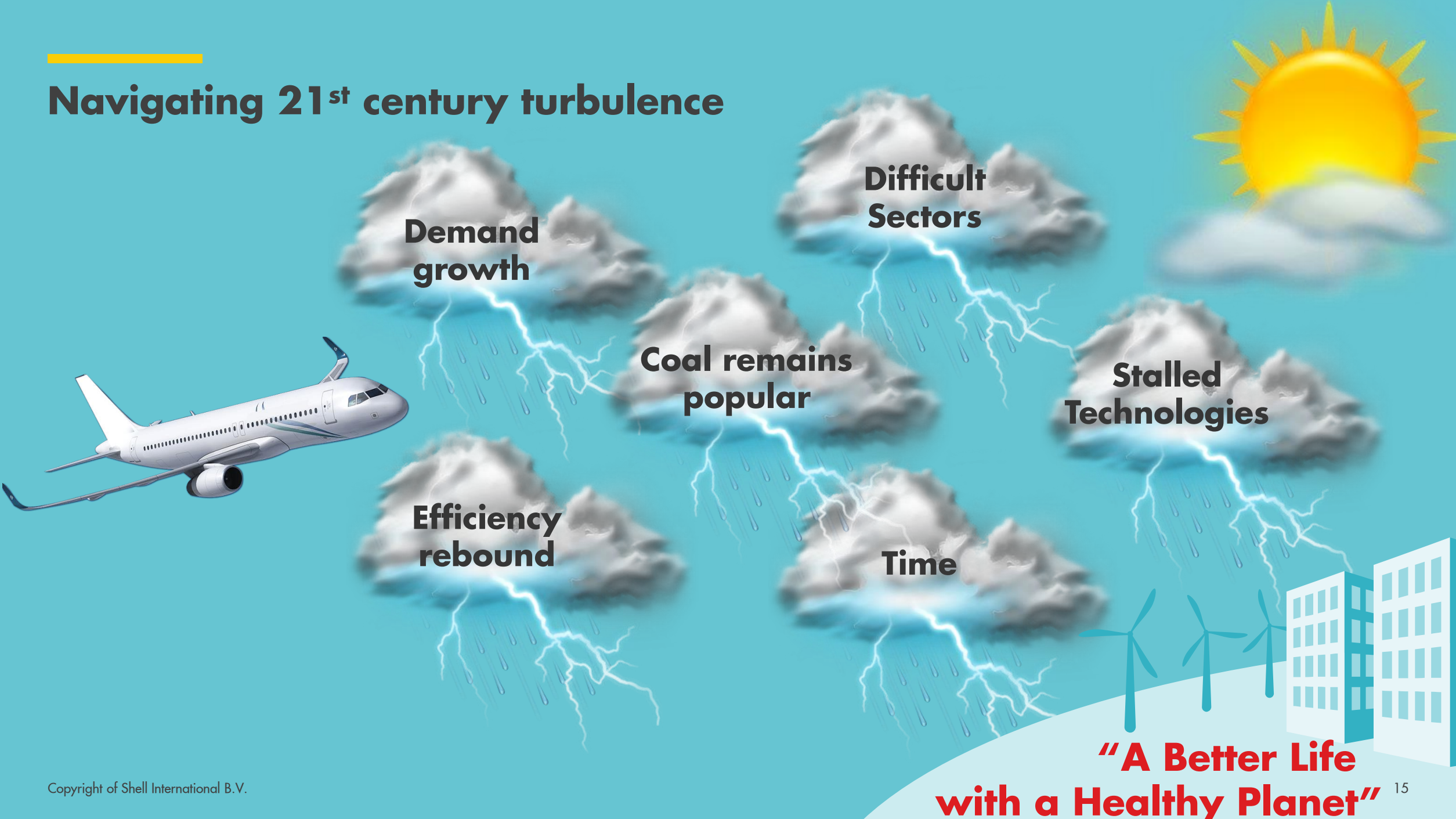


Source: UN Statistics



Source: Shell analysis

# Navigating 21<sup>st</sup> century turbulence





# The New Lens Scenarios Family

Looking  
beyond

**Mountains**  
and **Oceans**



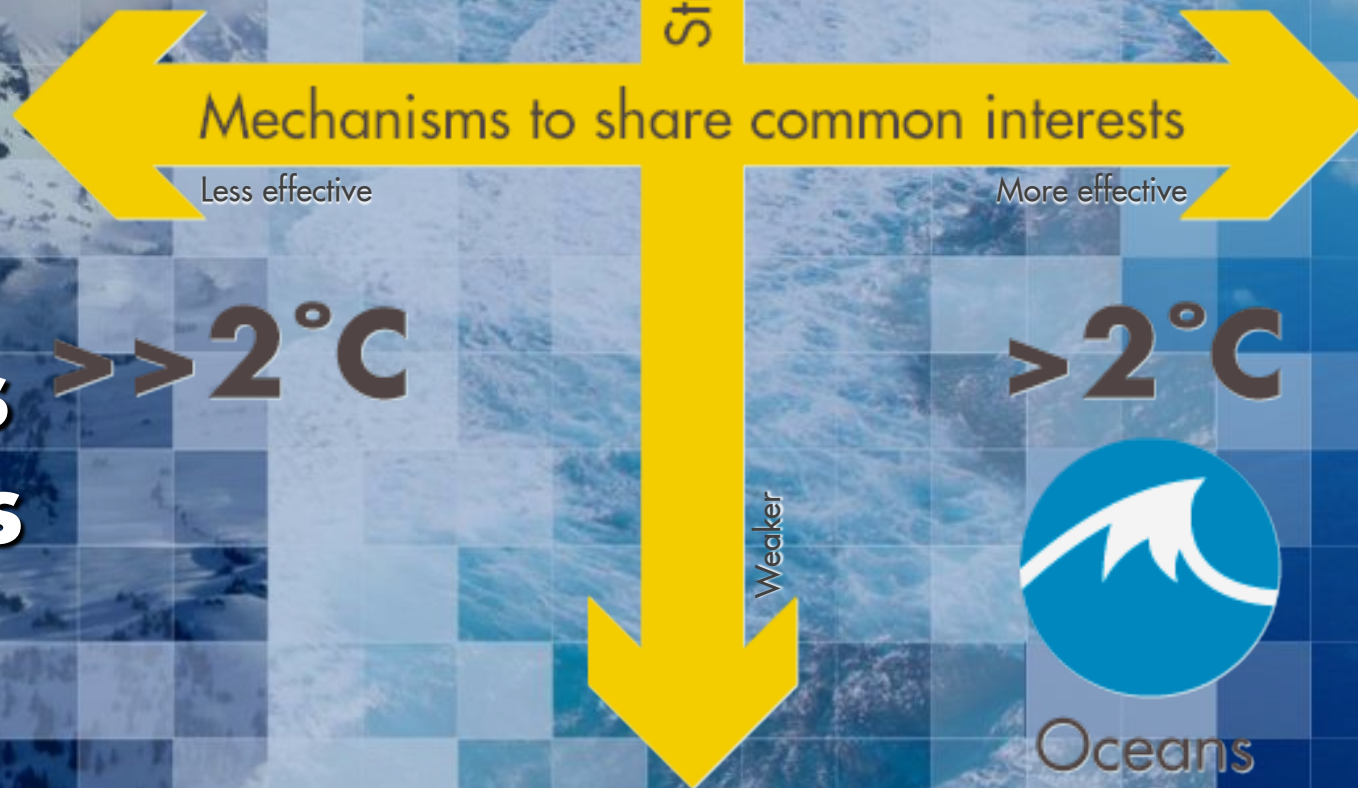
Mountains

**>2°C**



Sky

**<2°C**

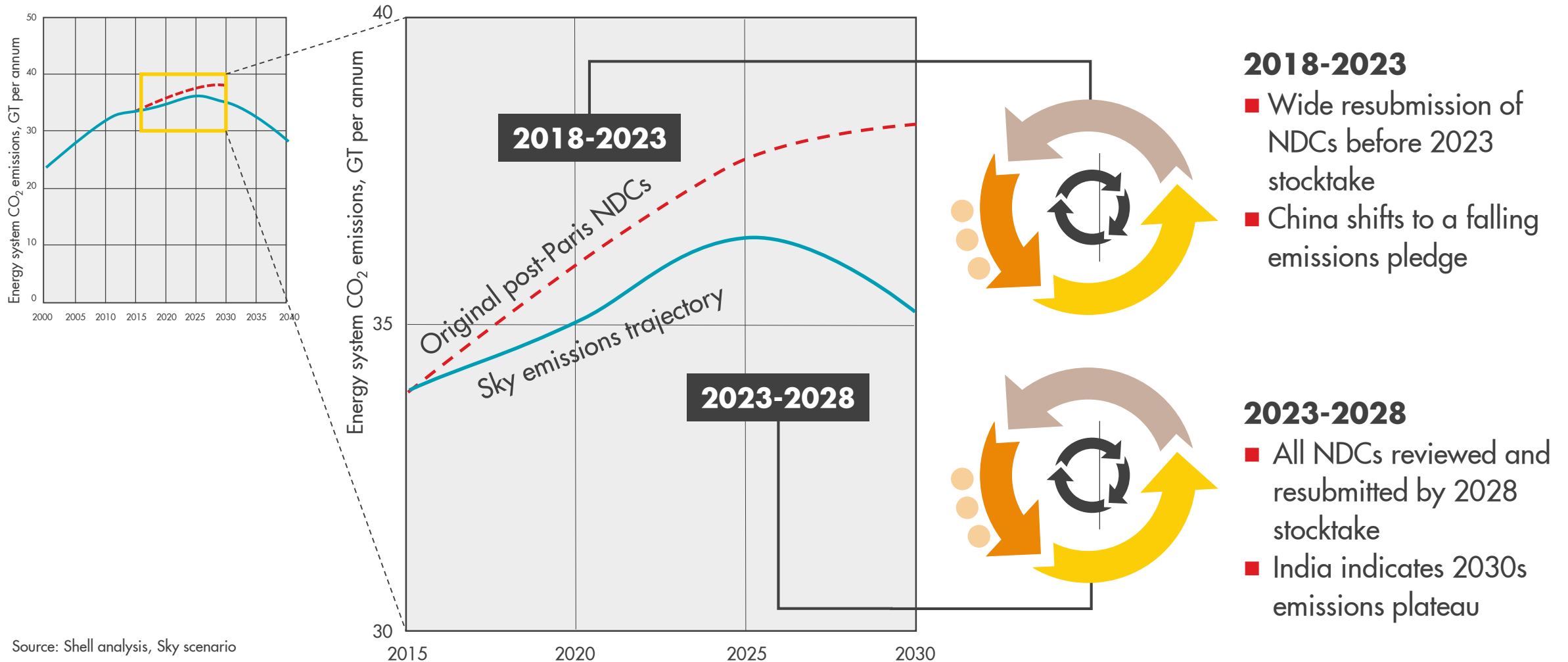


Oceans

. . . to **Sky**



# Sky begins in today's economic & policy realities, ratchets up action, then goal-seeks within techno-economic possibilities



# In Sky, six big steps forward from now to 2070 . . .



Carbon pricing



Energy efficiency



Electrification of  
final energy



Growing new  
energy systems



Carbon capture  
and storage



Reforestation



. . . underpinned by a changing consumer mind-set and societal license for change.



## Step 1 – Carbon pricing is essential within a broad policy framework

	Large point sources (electricity & industry)	Transport	Built environment (commercial & domestic)	Land use & agriculture
Discovery (R&D)	Significant step-up in clean technology research and development			<ul style="list-style-type: none"><li>• Adoption of best practices in farming (soil carbon)</li><li>• Widespread use of nature based solutions</li></ul>
Early & steep cost reductions	Effective government intervention through mandates and deployment supports, etc.			
Rapid long term deployment	Broad incentive policies such as carbon pricing & growing climate bias in financial markets.			

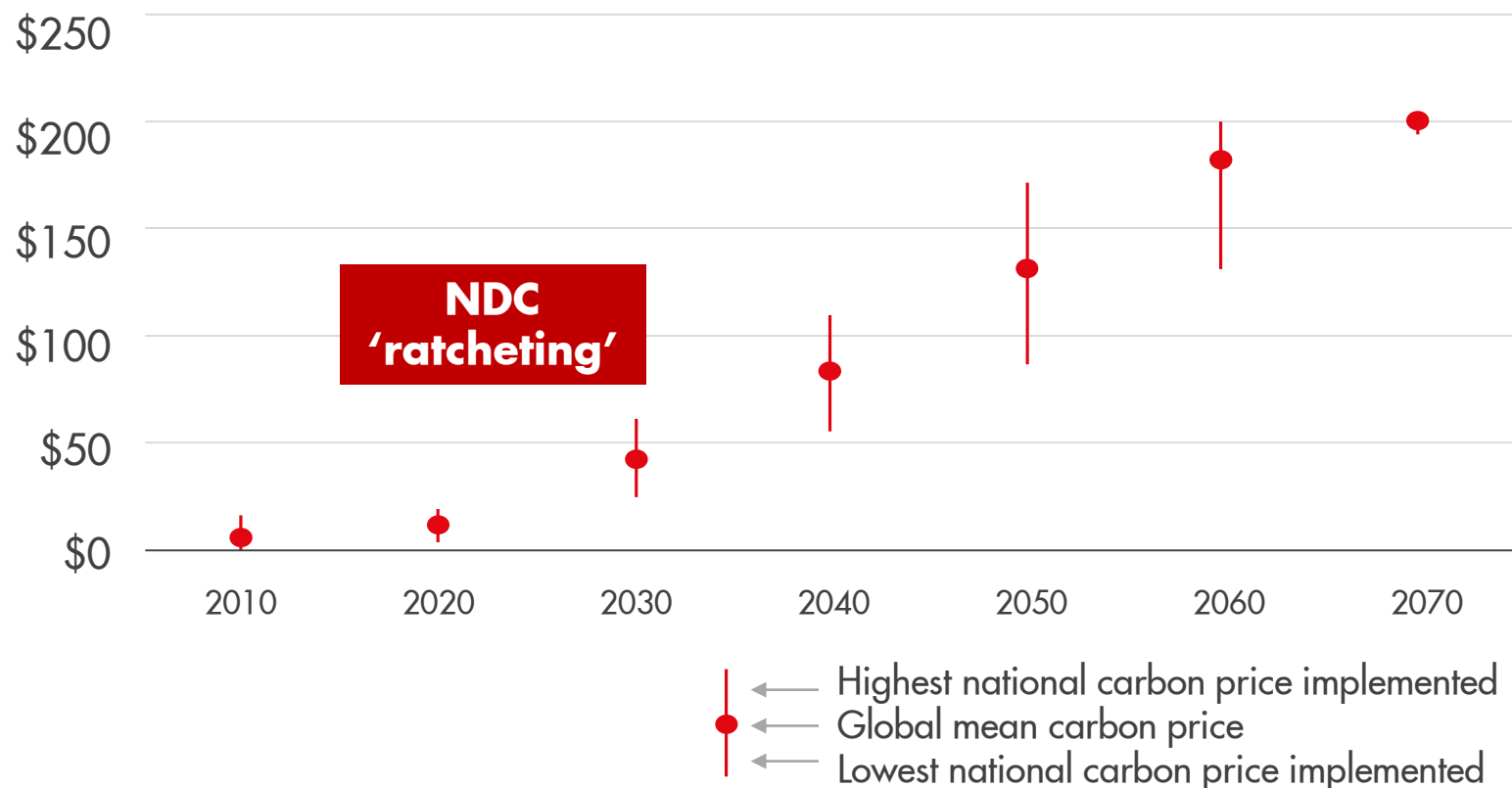


Unwavering acceleration and coordination:

- Market & fiscal mechanisms
- Standards & mandates
- Investments in infrastructure & technology

# Globally, the carbon price ramps up during the 2020s

Carbon prices in Sky, \$/tonne CO<sub>2</sub>



Source: Shell analysis, Sky scenario  
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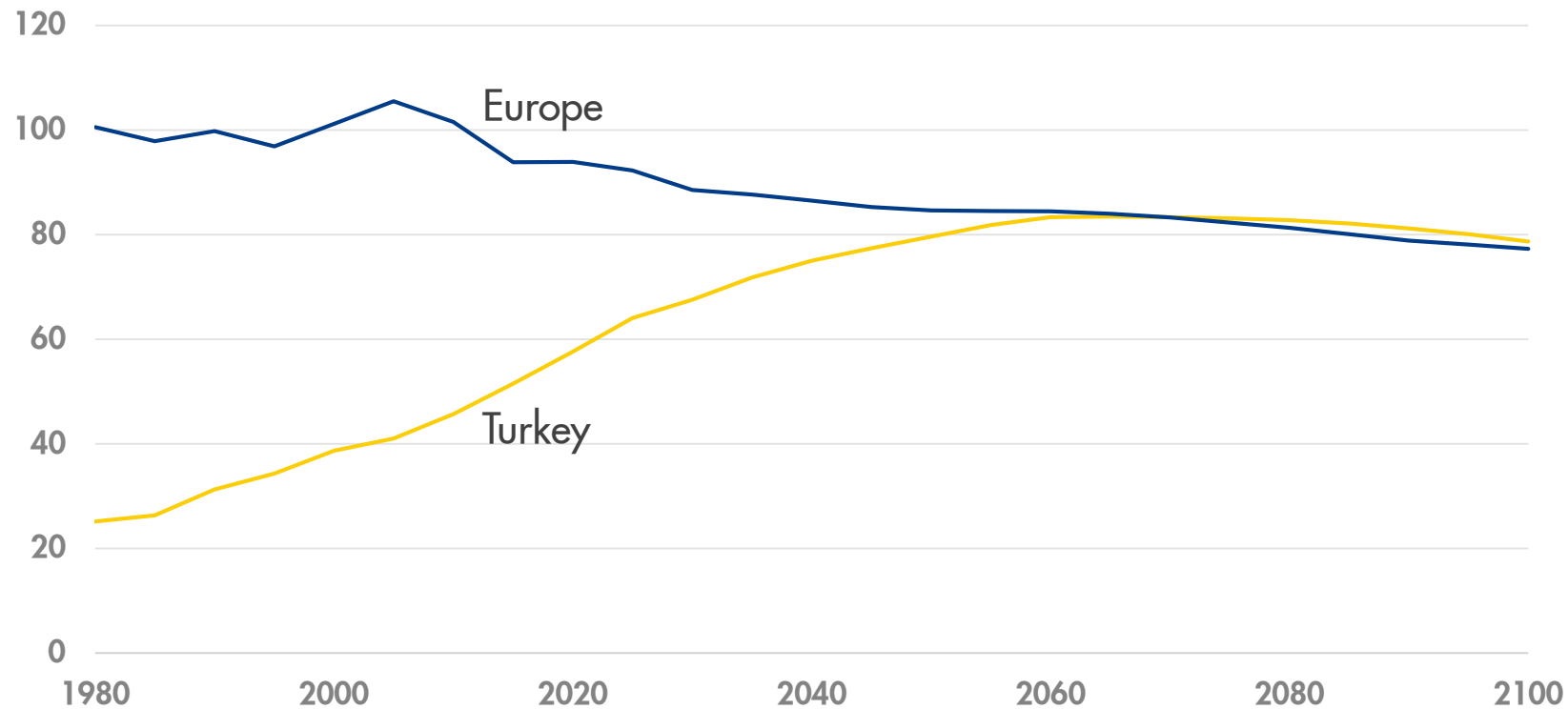
Unwavering acceleration and coordination:

- Market & fiscal mechanisms
- Standards & mandates
- Investments in infrastructure & technology



## Step 2 – Efficiency is essential for limiting demand growth as development proceeds

Final energy consumption, GJ per year per person

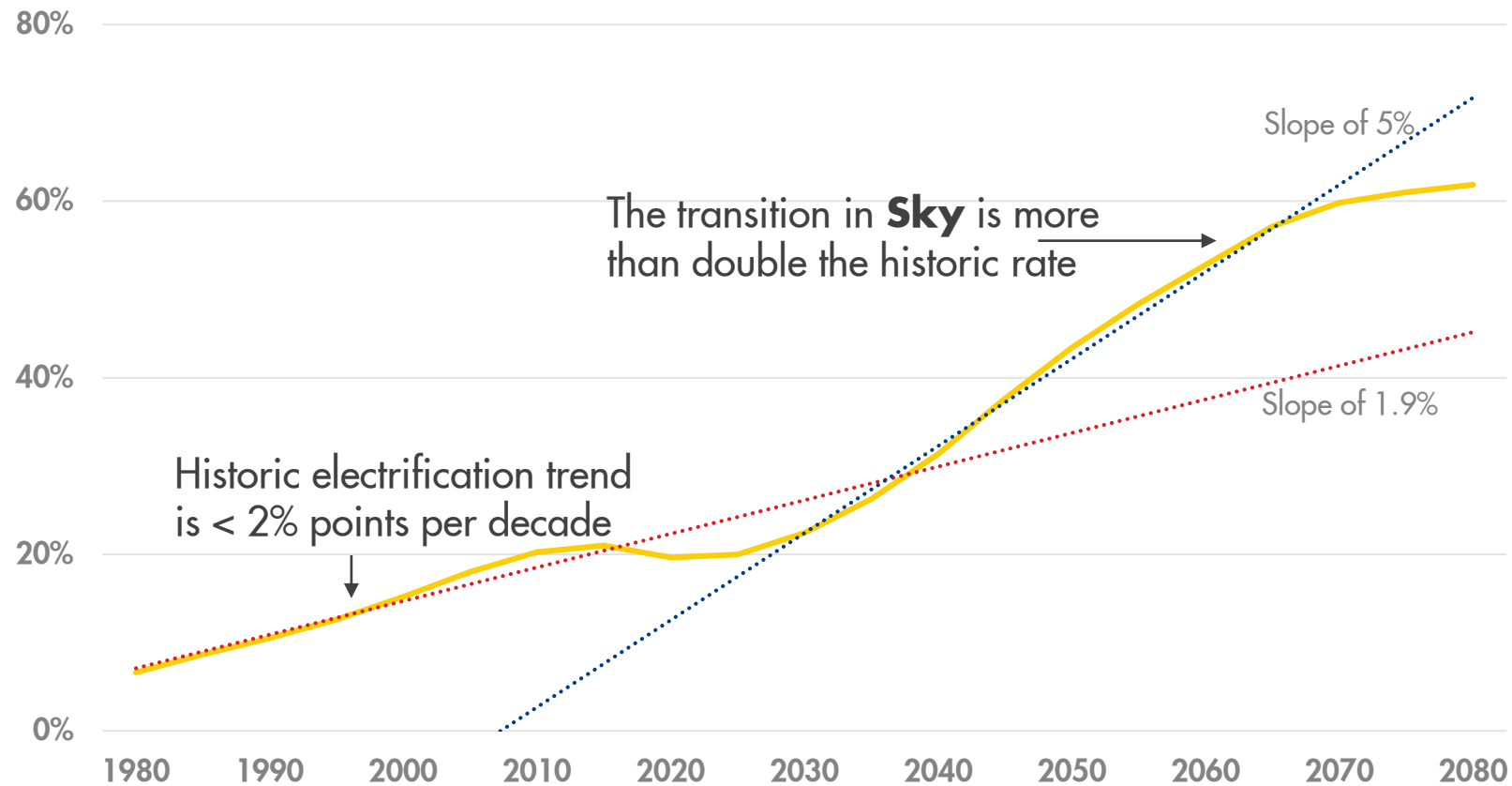


Source: Shell analysis, Sky scenario  
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## Step 3 – A major ramp-up in electrification

### Electricity as a % of final energy use in Turkey

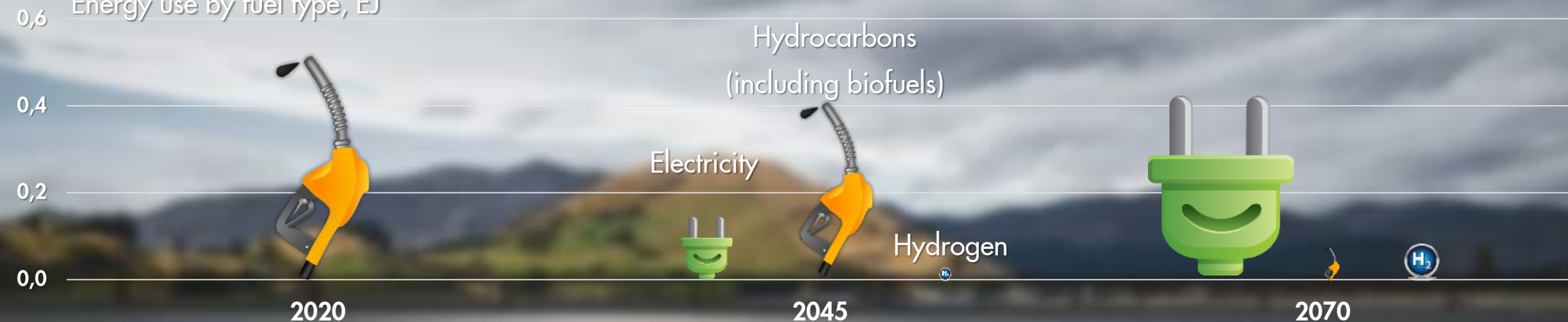


Source: Shell analysis, Sky scenario  
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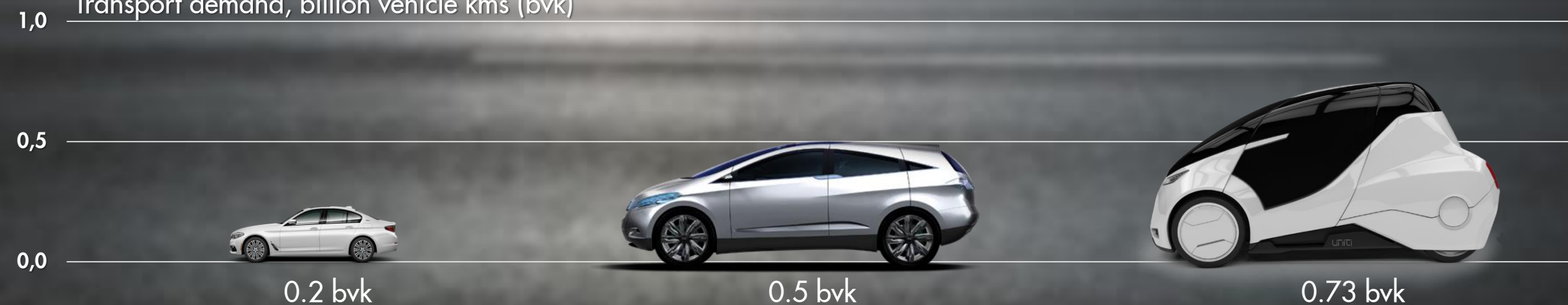


# Turkey passenger road transport trends in Sky

Energy use by fuel type, EJ



Transport demand, billion vehicle kms (bvk)



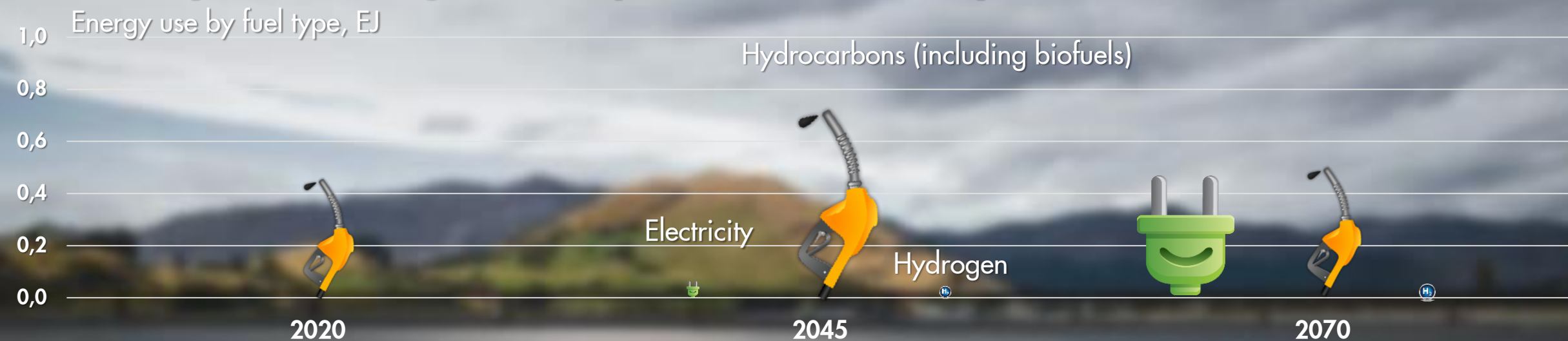
Source: Shell analysis, Sky scenario

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# Turkey road freight transport trends in Sky

Energy use by fuel type, EJ



Freight demand, billion tonne kms (btk)



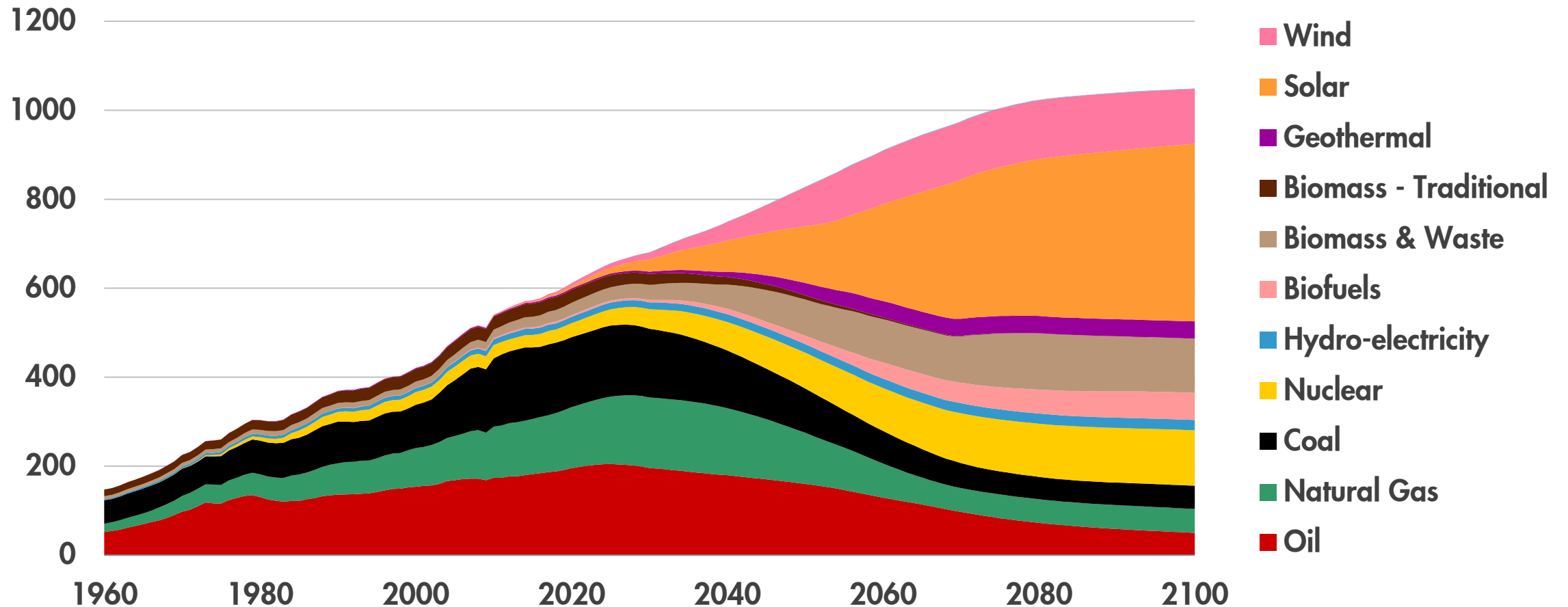
Source: Shell analysis, Sky scenario

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## Step 4 – New energy systems emerge

The major sources of primary energy shift in Sky

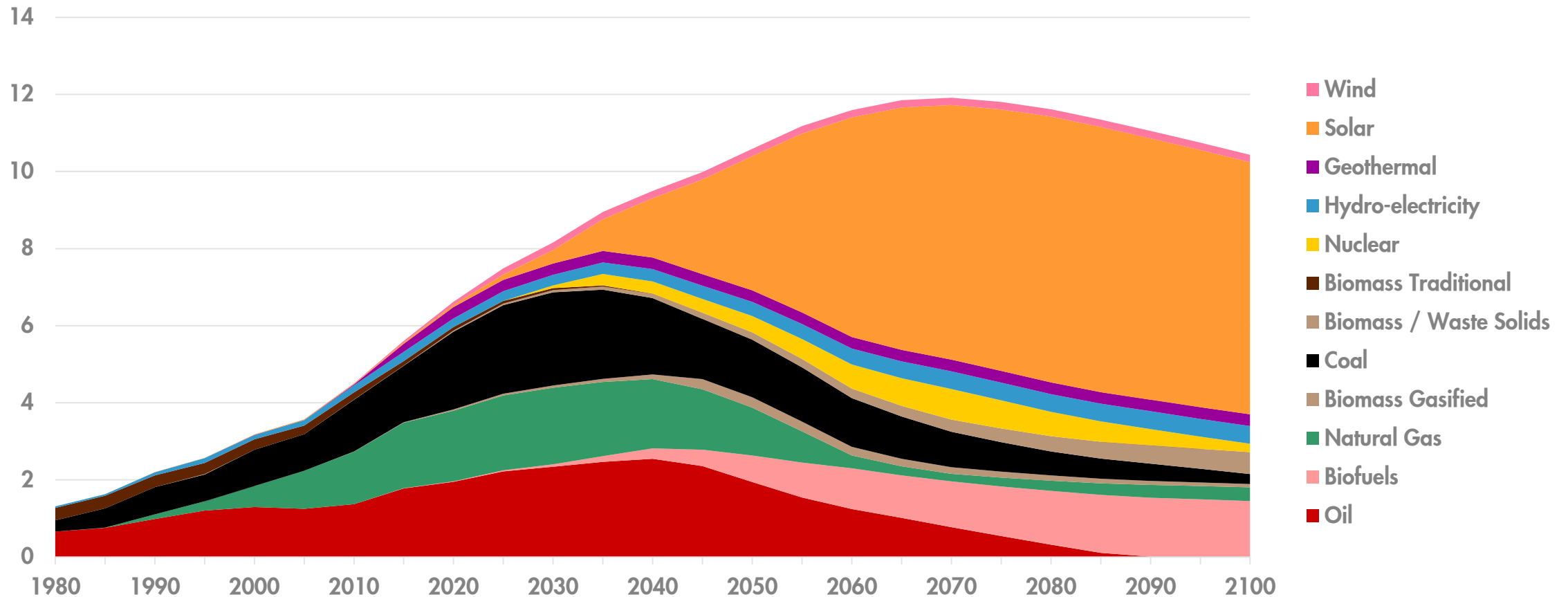
World total primary energy by source, EJ/year



Source: Shell analysis, Sky scenario  
Copyright of Shell International B.V.

# In Turkey, solar dominates in the second half of the century

Turkey total primary energy by source, EJ/year

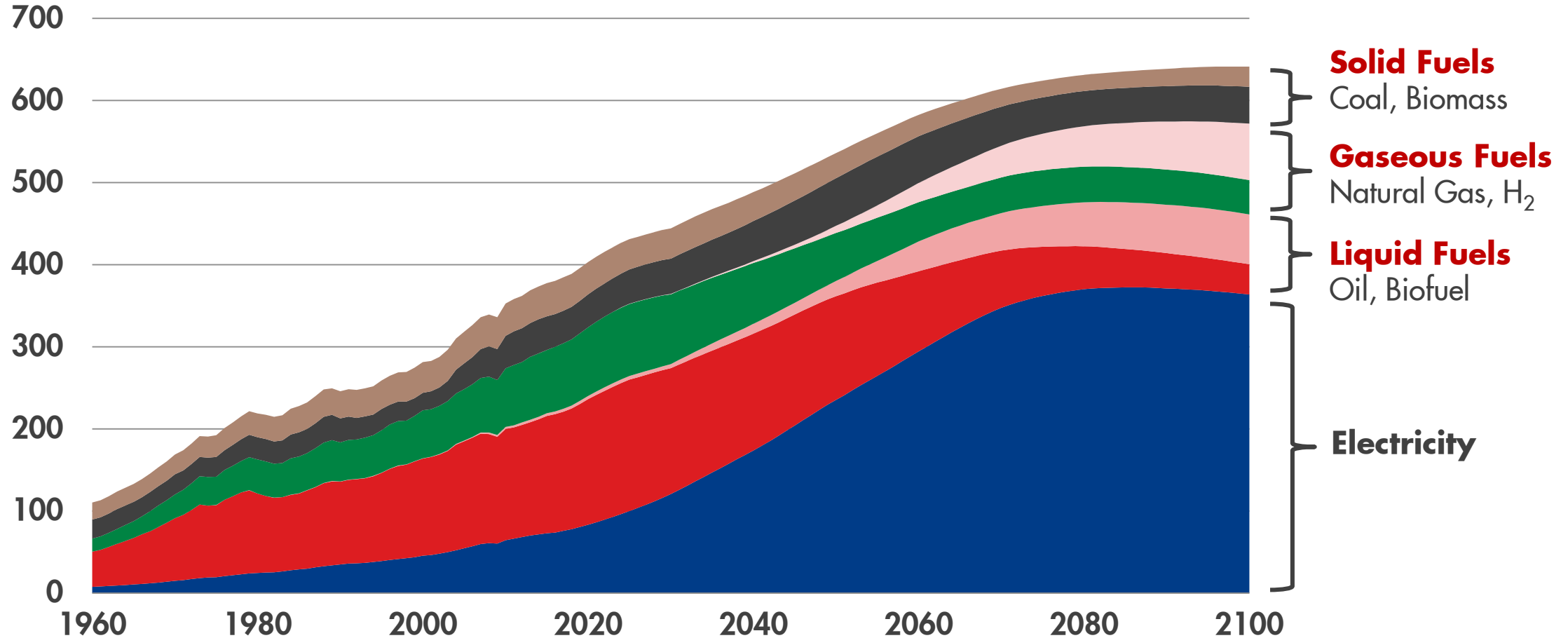


Source: Shell analysis, Sky scenario  
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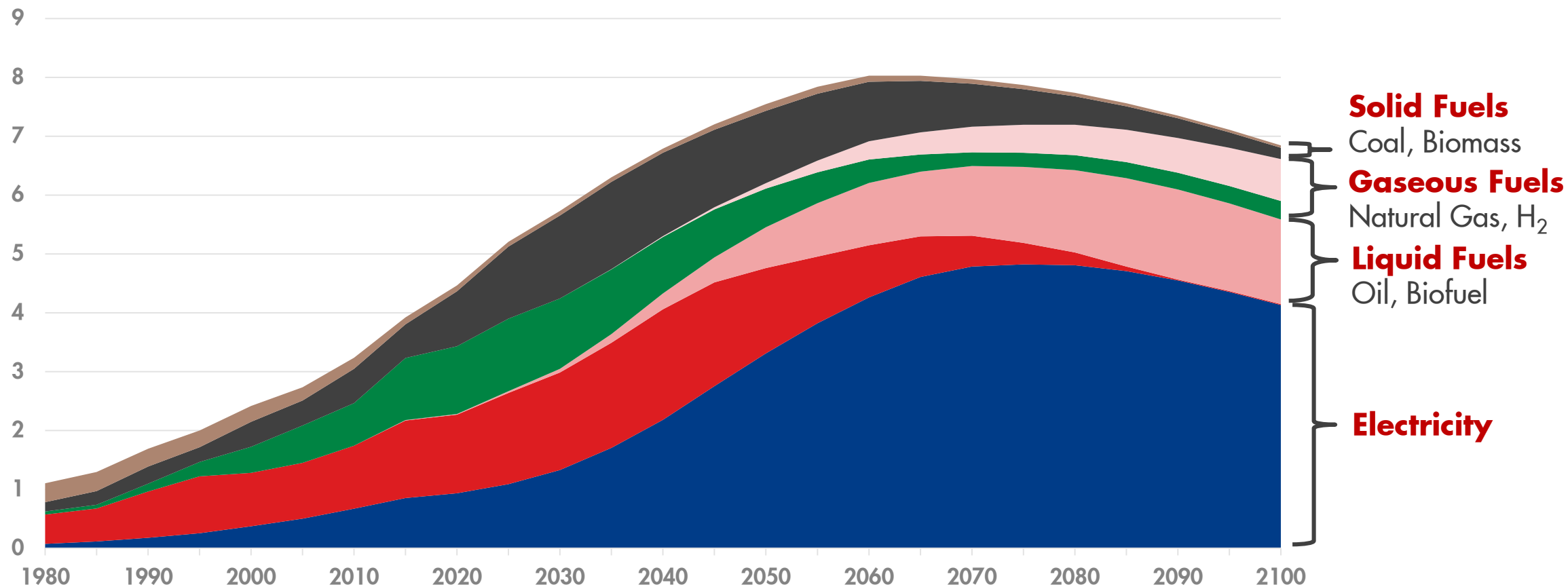
# In Sky, deep electrification, but molecules remain important

Global end-use energy consumption, EJ/year

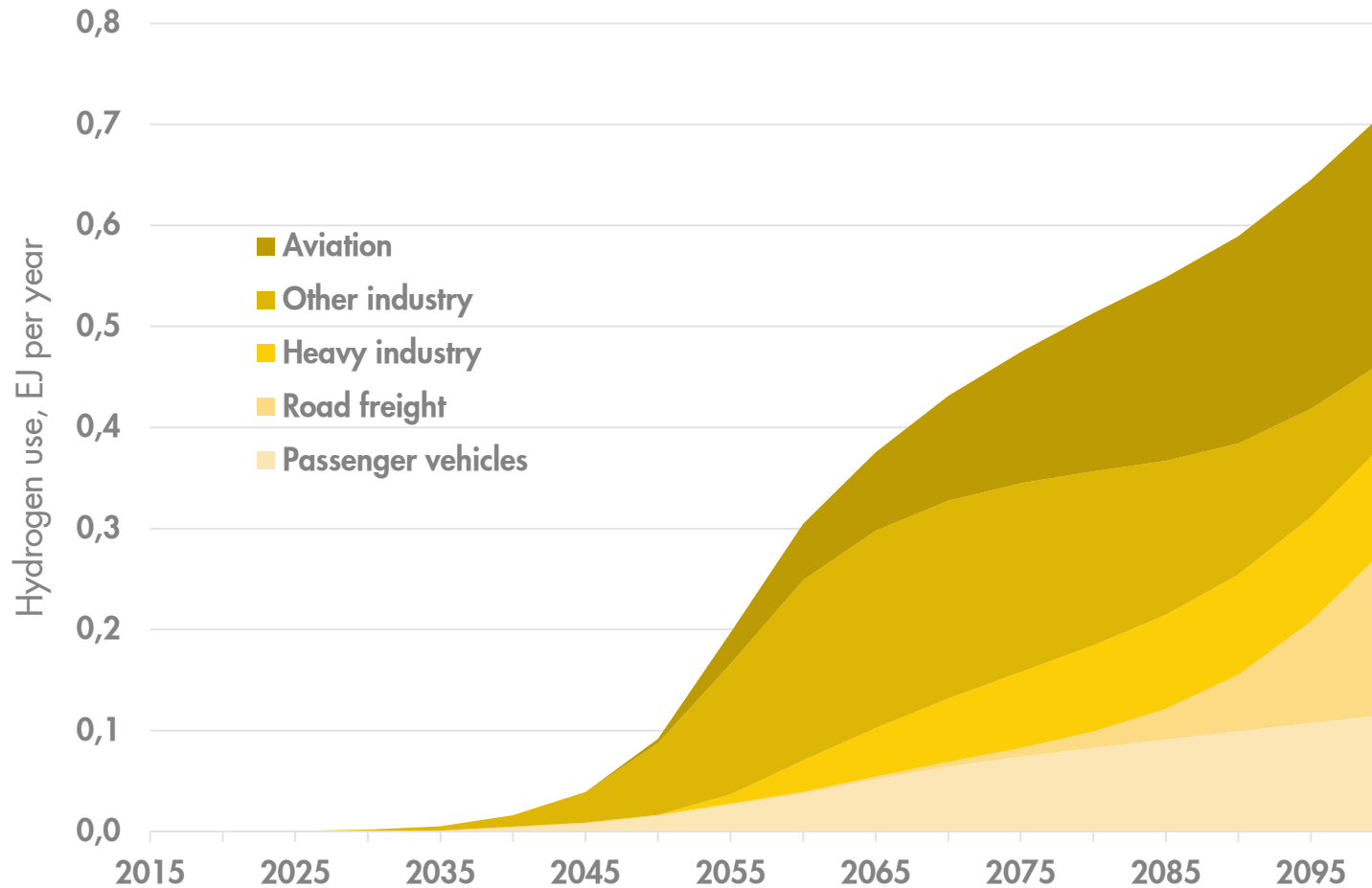


## Similar trends emerge in Turkey

Turkey end-use energy consumption, EJ/year

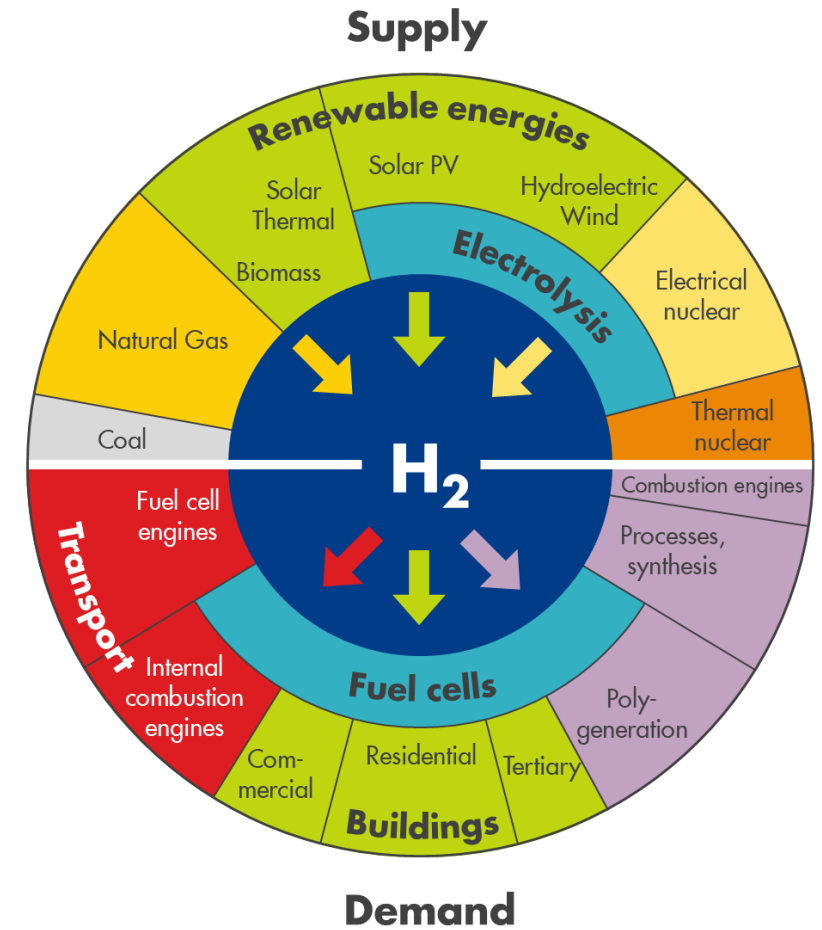


# A hydrogen based energy system emerges in Turkey in the 2030s



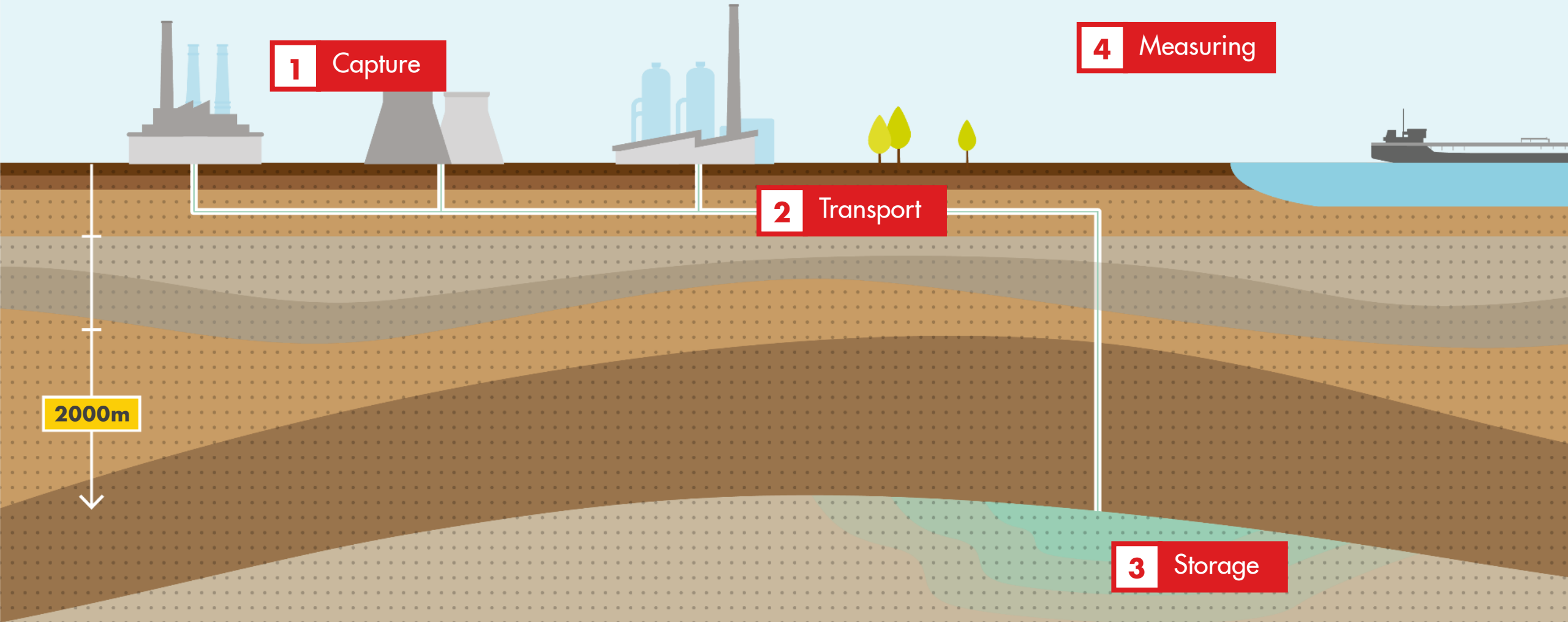
Source: Shell schematic

Copyright of Shell International B.V.

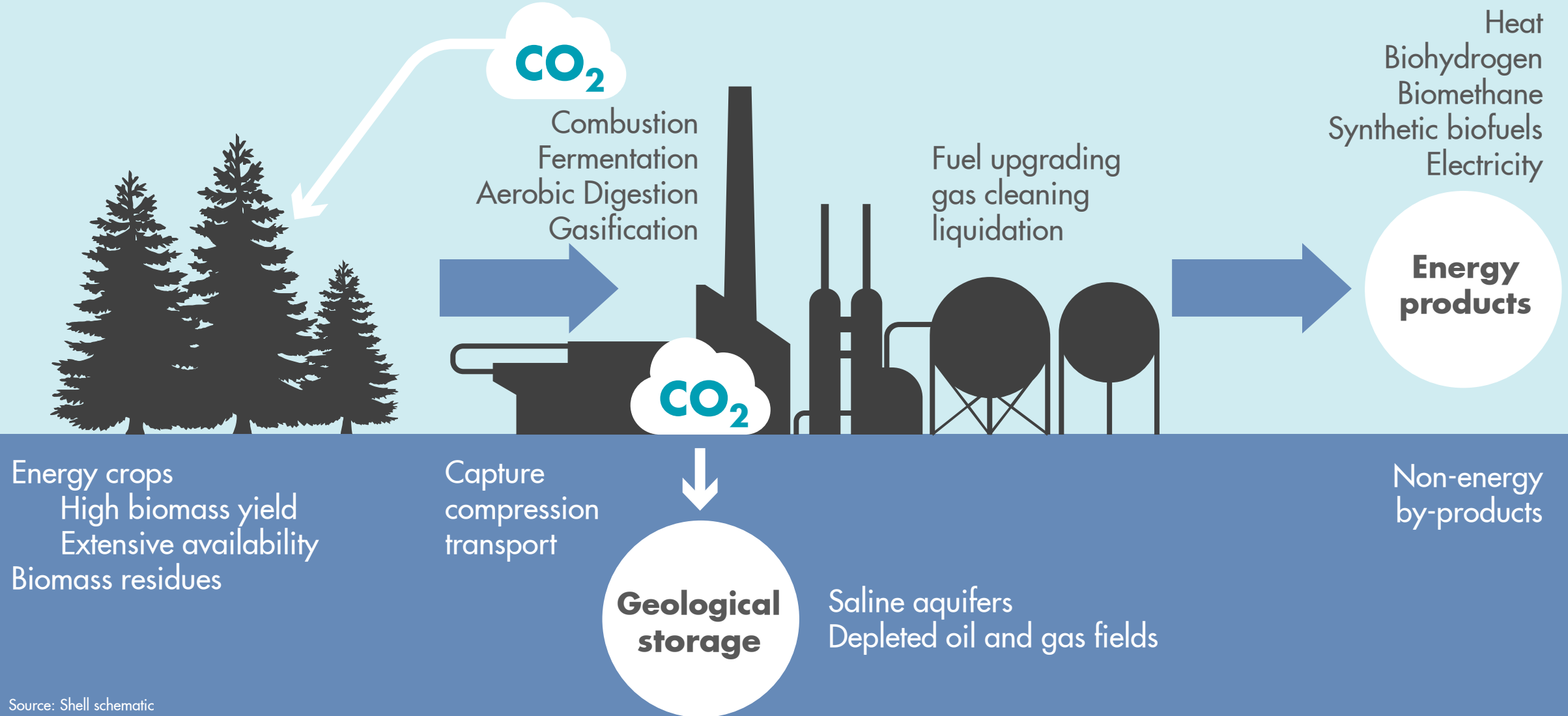




## Step 5 – A man-made sink: Carbon capture and storage (CCS)

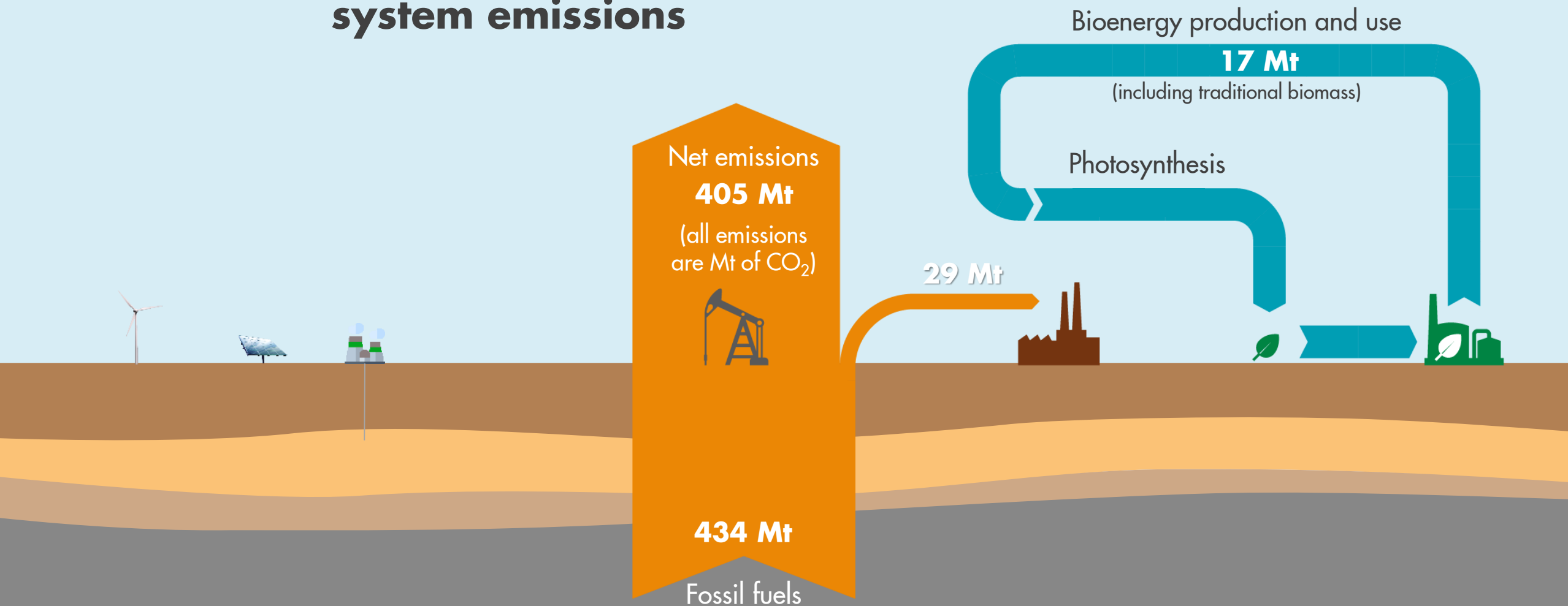


# Bioenergy with CCS has a role to play in Turkey



# 2020

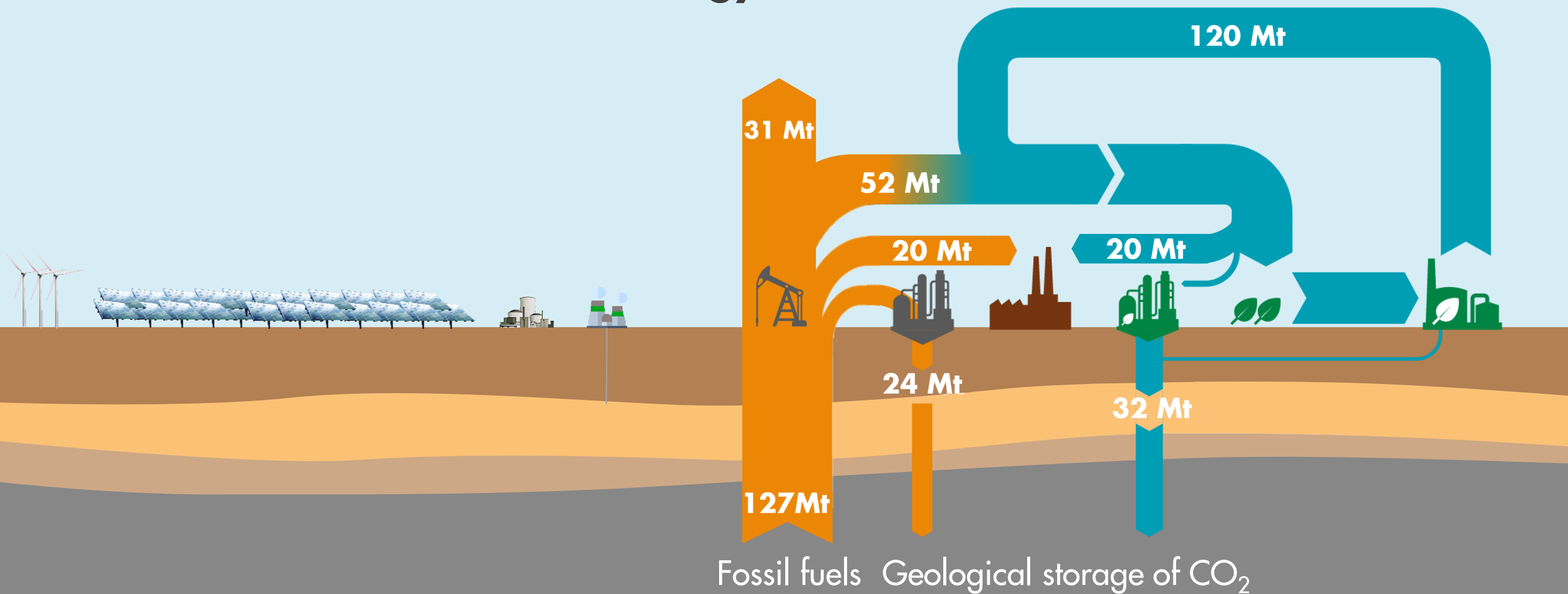
## Sky Turkey: Current energy system emissions





# 2070

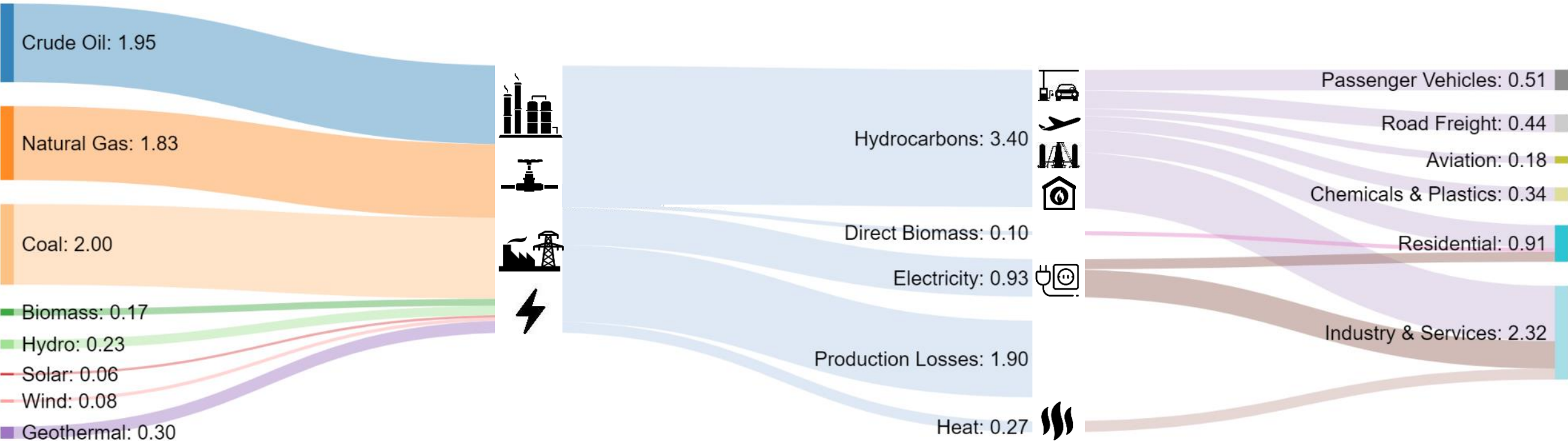
## Sky Turkey: Approaching net-zero emissions for energy



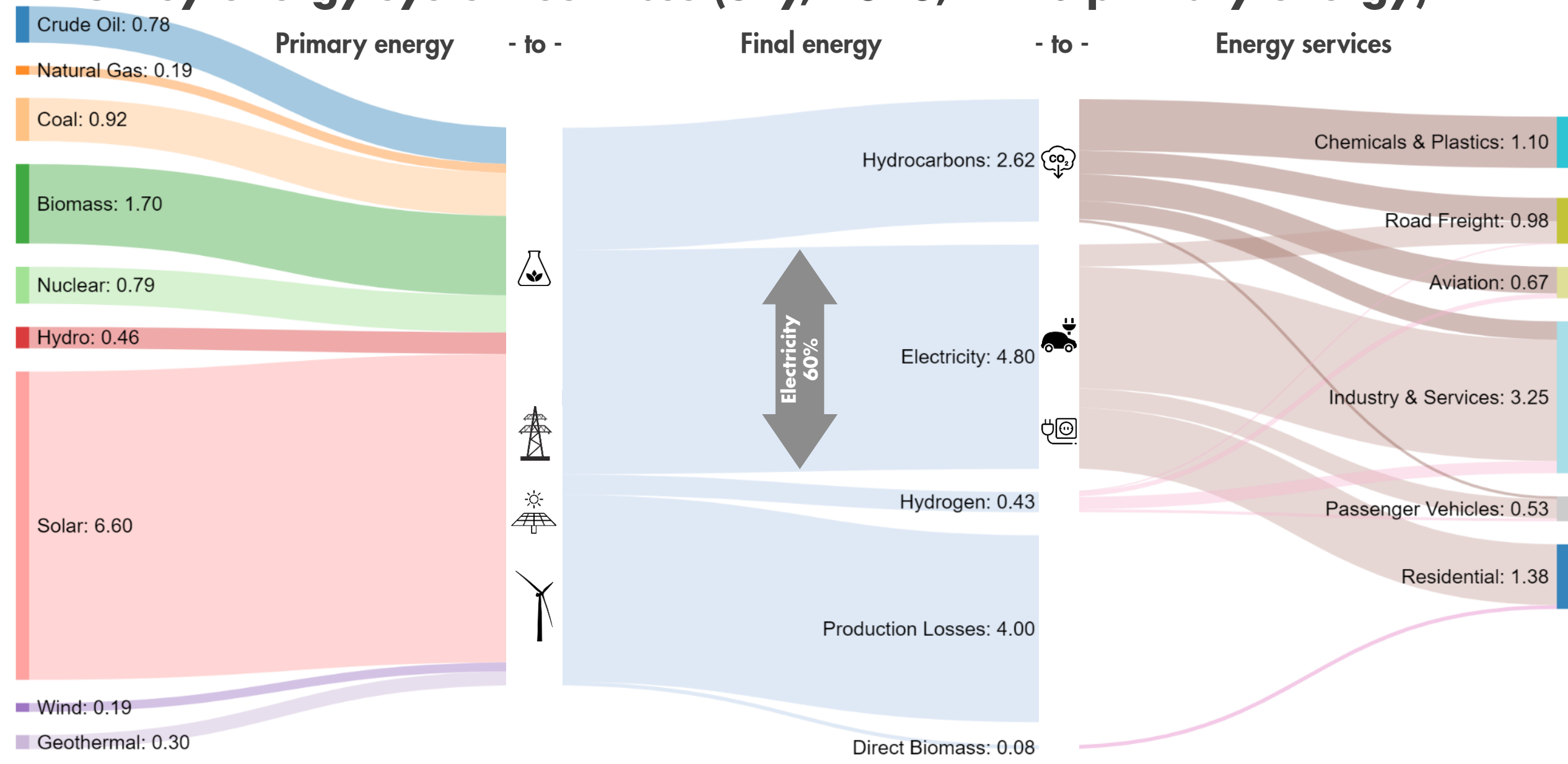


# Turkey energy system services (Sky, 2020, 7 EJ primary energy)

Primary energy - to - Final energy - to - Energy services

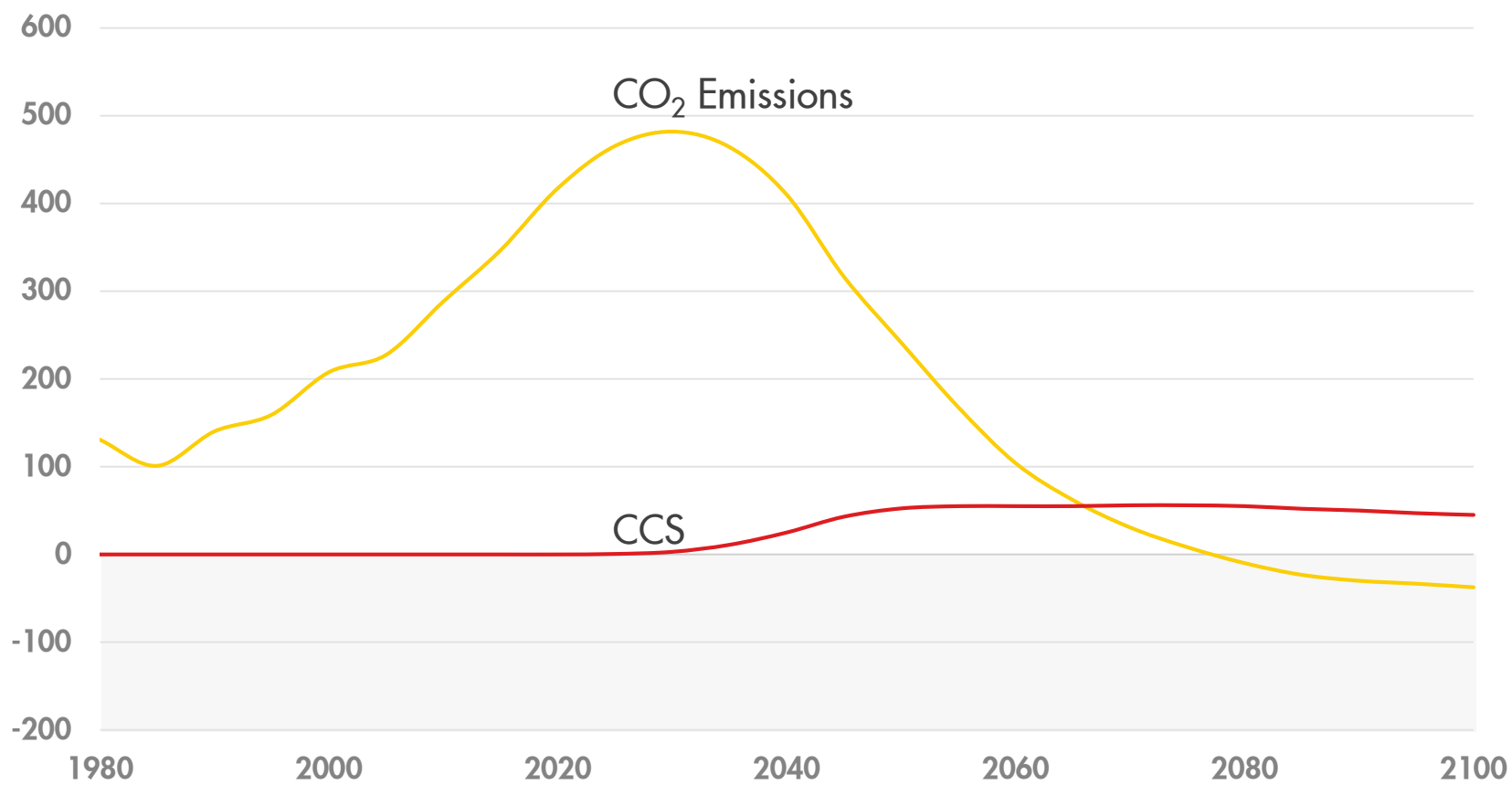


# Turkey energy system services (Sky, 2070, 12 EJ primary energy)



# Sky Turkey: Energy-related emissions and CCS

Energy-related CO<sub>2</sub> (all energy) and CCS, millions of tons



Source: Shell analysis, Sky scenario  
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## Step 6 – Widespread reforestation and afforestation

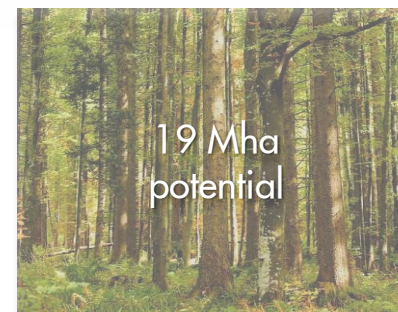


# Potential Turkey contribution to global reforestation in Sky 1.5°C

(The Nature Conservancy)



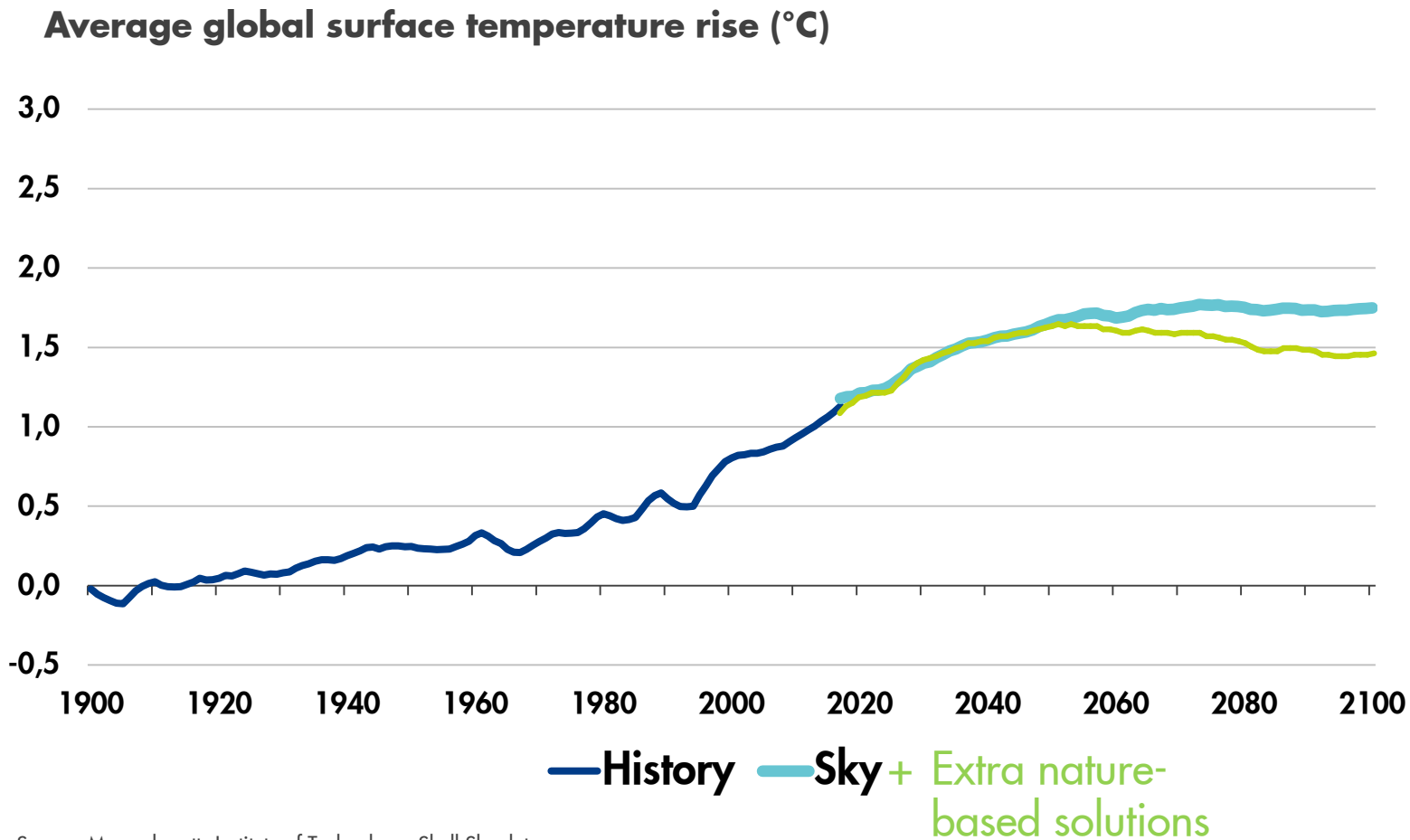
Turkey: 78 Mha land area  
~ 19 Mha reforestation potential  
~300 million tons CO<sub>2</sub> per year





# Sky meets the Paris goal

## MIT assessment of climate impact



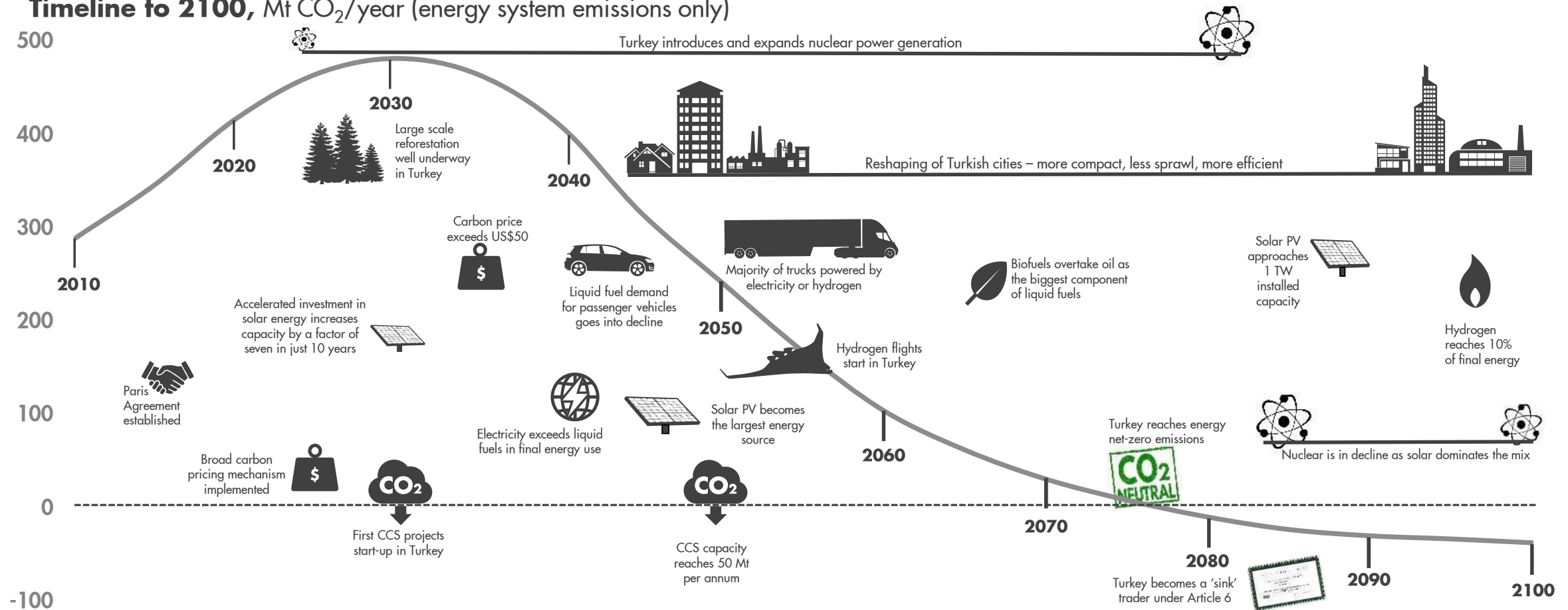
Source: Massachusetts Institute of Technology, Shell Sky data  
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# Sky Turkey: Significant changes ahead

Striving for net-zero emissions is underpinned by major technological, economic, political and social breakthroughs

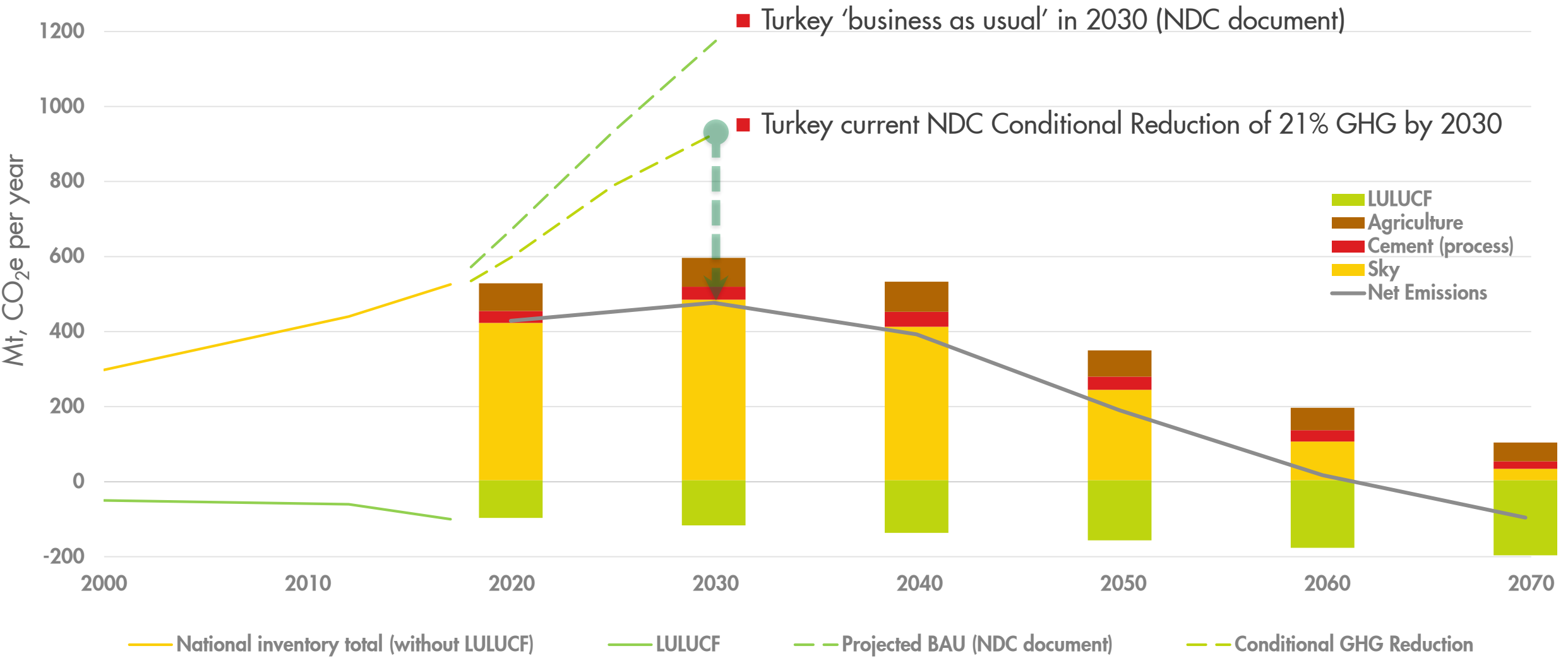
Timeline to 2100, Mt CO<sub>2</sub>/year (energy system emissions only)







# The Sky Scenario and the Turkey National Contribution to Paris



# Possible directions from Sky for Turkey NDC submission in 2020

Potential contribution to the Paris Agreement:

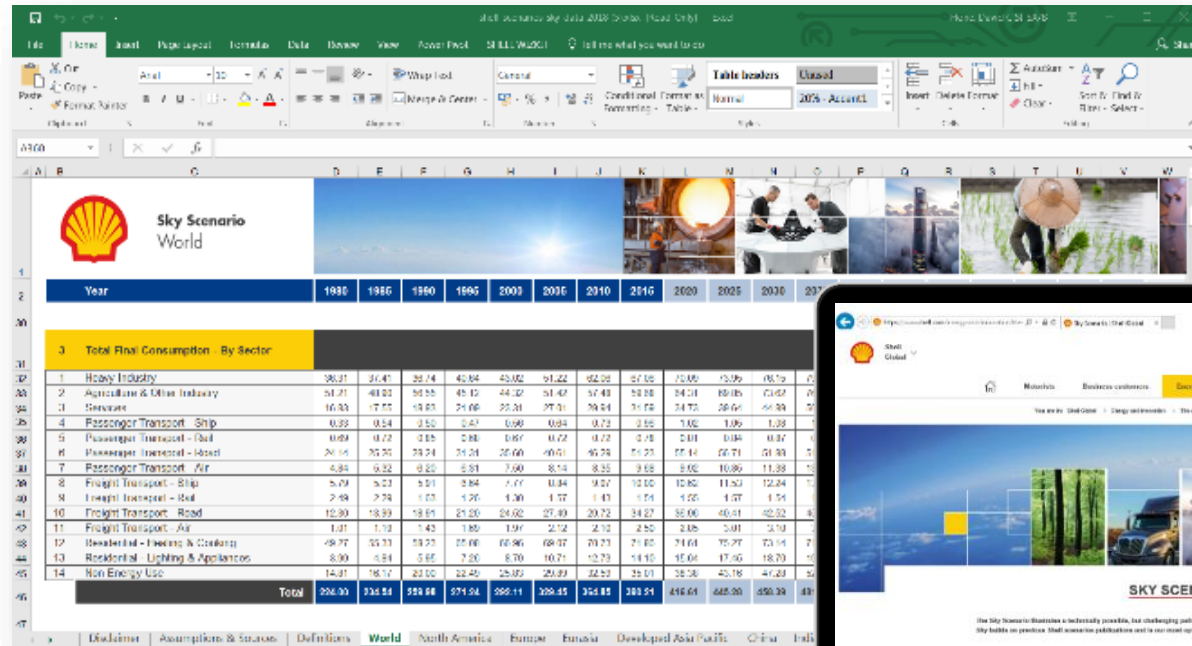
- Emissions peaking by 2030 (and falling thereafter);
- Peak of 600-650 Mt gross emissions, <500 Mt net emissions (with LULUCF)
- Indicative year of 2060 for net-zero emissions (with LULUCF)

Supported by:

- Significant expansion of solar PV, ~50 GW by 2030
- Coal peak by 2030 at the latest
- Rapid reforestation
- First industrial CCS projects up and running during the 2020s
- Step up in biofuel production and biomass in energy
- 15% passenger vehicle travel in EVs

# Additional reading and the Sky dataset

[www.shell.com/skyscenario](http://www.shell.com/skyscenario)



Year	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075
<b>3 Total Final Consumption - By Sector</b>																				
1 Heavy Industry	38.91	31.47	29.74	42.84	43.02	51.42	62.26	67.55	72.65	73.05	73.05	73.05	73.05	73.05	73.05	73.05	73.05	73.05	73.05	73.05
2 Agriculture & Other Industry	51.21	48.82	50.55	45.12	44.32	51.42	57.43	58.88	54.31	55.85	54.31	54.31	54.31	54.31	54.31	54.31	54.31	54.31	54.31	54.31
3 Services	16.83	17.15	18.85	21.66	23.31	27.91	38.54	51.78	54.75	58.61	64.58	71.64	78.71	85.78	92.85	99.92	106.99	114.06	121.13	128.20
4 Passenger Transport - Ship	0.39	0.54	0.52	0.47	0.50	0.54	0.72	0.85	1.00	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
5 Passenger Transport - Road	0.69	0.72	0.85	0.84	0.87	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
6 Passenger Transport - Air	24.14	25.20	28.24	31.24	28.66	40.71	45.26	51.23	57.14	63.11	69.11	75.11	81.11	87.11	93.11	99.11	105.11	111.11	117.11	123.11
7 Freight Transport - Ship	4.84	6.32	8.22	8.51	7.60	8.14	8.35	9.68	9.95	10.95	11.95	12.95	13.95	14.95	15.95	16.95	17.95	18.95	19.95	20.95
8 Freight Transport - Road	5.09	6.23	8.21	8.84	7.77	10.34	10.27	12.00	12.82	13.82	14.82	15.82	16.82	17.82	18.82	19.82	20.82	21.82	22.82	23.82
9 Freight Transport - Air	2.49	2.74	1.23	1.26	1.30	1.32	1.43	1.54	1.65	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67	1.67
10 Residential - Heating & Cooling	12.80	18.89	18.81	21.20	24.62	27.49	29.72	34.27	38.00	40.61	42.52	44.43	46.34	48.25	50.16	52.07	53.98	55.89	57.80	59.71
11 Residential - Lighting & Appliances	1.01	1.10	1.43	1.85	1.97	2.12	2.12	2.85	2.85	3.01	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10	3.10
12 Non Energy Use	48.77	55.33	53.23	55.66	60.96	68.07	70.73	71.80	71.64	75.27	73.14	73.14	73.14	73.14	73.14	73.14	73.14	73.14	73.14	73.14
<b>Total</b>	<b>294.30</b>	<b>334.54</b>	<b>359.88</b>	<b>374.54</b>	<b>388.11</b>	<b>398.45</b>	<b>354.85</b>	<b>383.51</b>	<b>416.01</b>	<b>445.01</b>	<b>465.30</b>	<b>485.59</b>	<b>505.88</b>	<b>526.17</b>	<b>546.46</b>	<b>566.75</b>	<b>587.04</b>	<b>607.33</b>	<b>627.62</b>	<b>647.91</b>

