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Scenarios for the Grid Development Plan in Germany

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Lessons from Denmark: Towards a Renewable Future

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Topic Overwiev

1. Grid Development: Why?

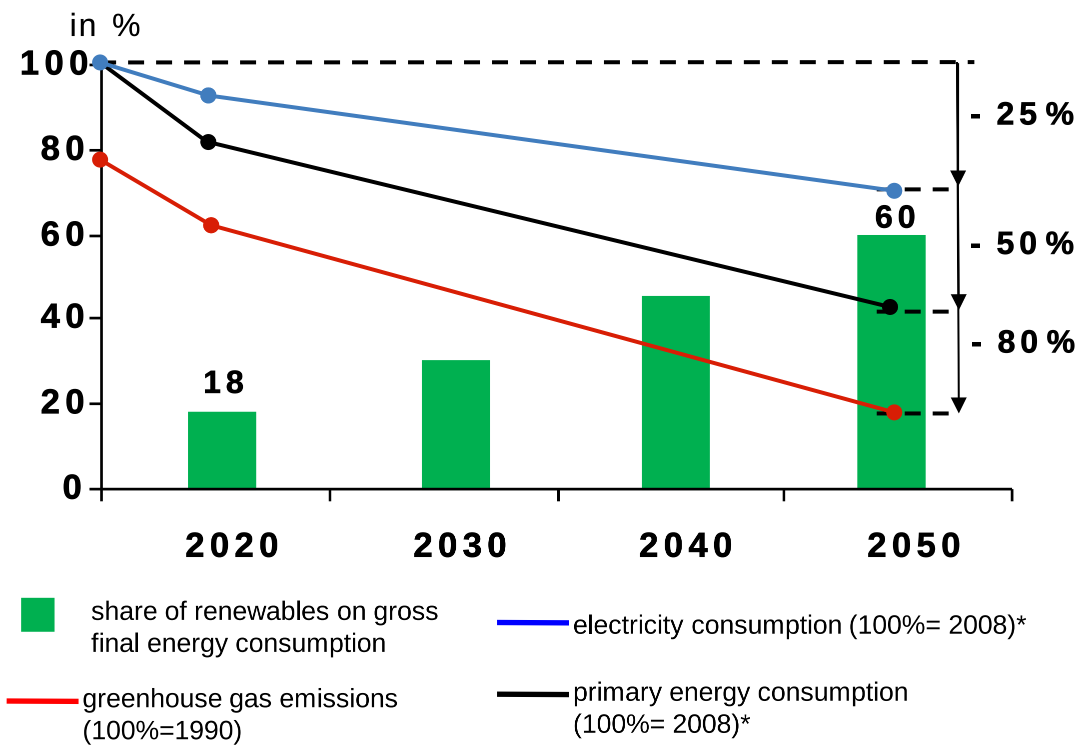
2. Grid Development Process

3. Scenario Framework for the Grid Development Plan 2025

1. Grid Development: Why?

Climate protection as Germany‘s priority target

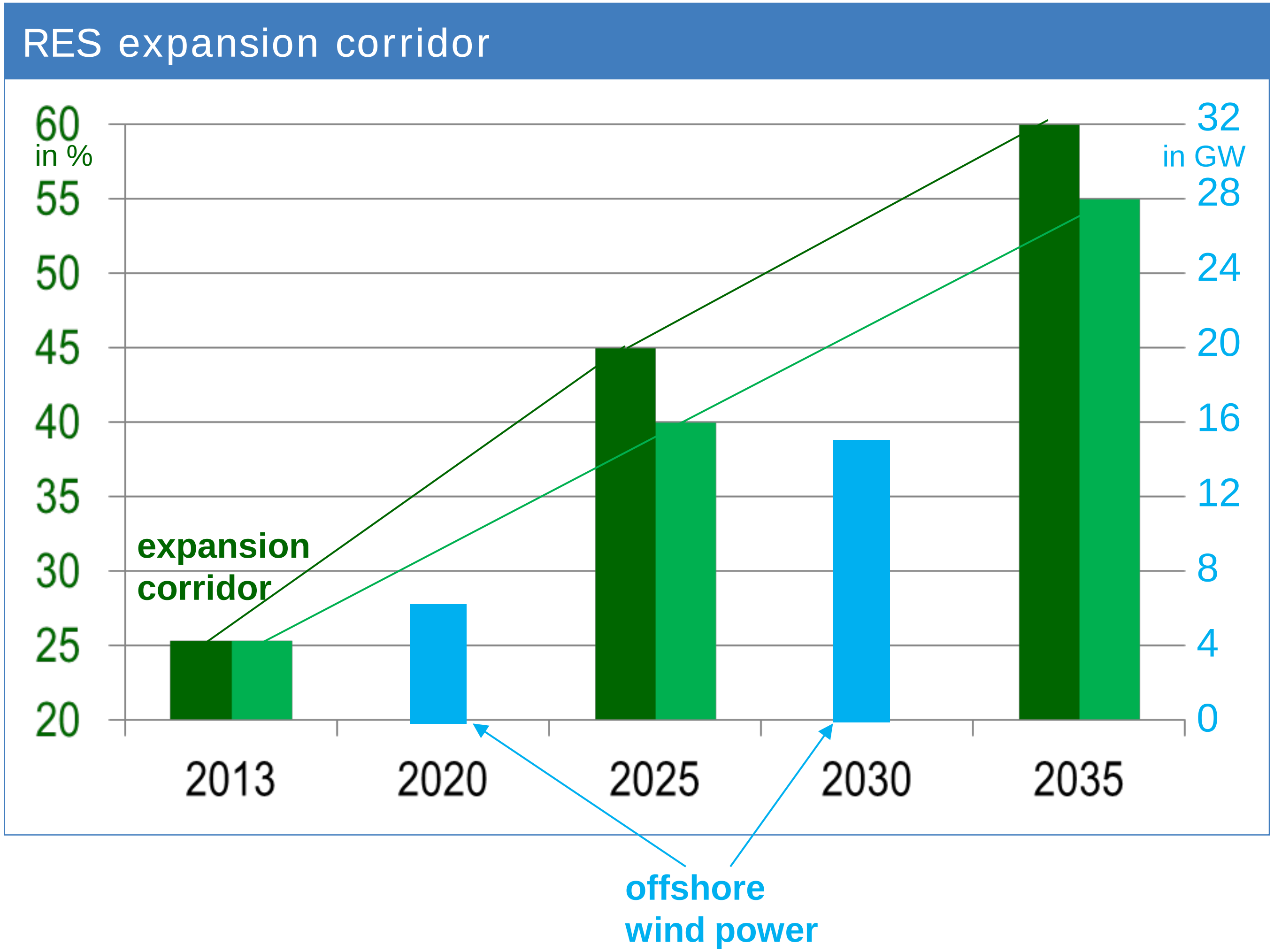
The Federal Government‘s Energy Concept (2010)



Targets by 2050:

- **Decrease of greenhouse gas emissions by 80 % in comparison to 1990**
- **Reduction of electricity consumption by 25 % in comparison to 2008**
- **Reduction of primary energy consumption by 50 % in comparison 2008**

Government targets for Renewable Electricity



RES-share on gross electrictiy consumption in %

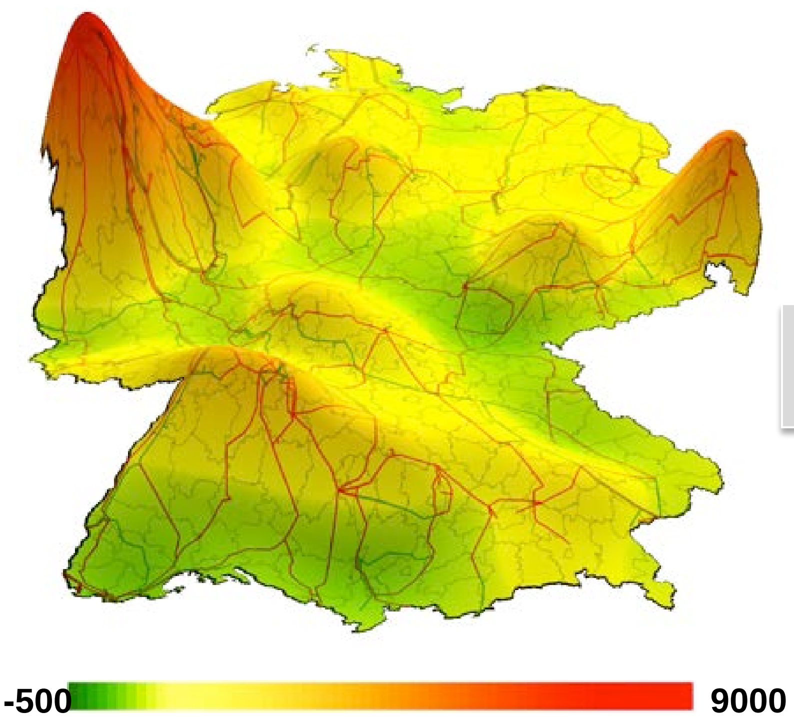
expansion corridor upper bound

expansion corridor lower bound

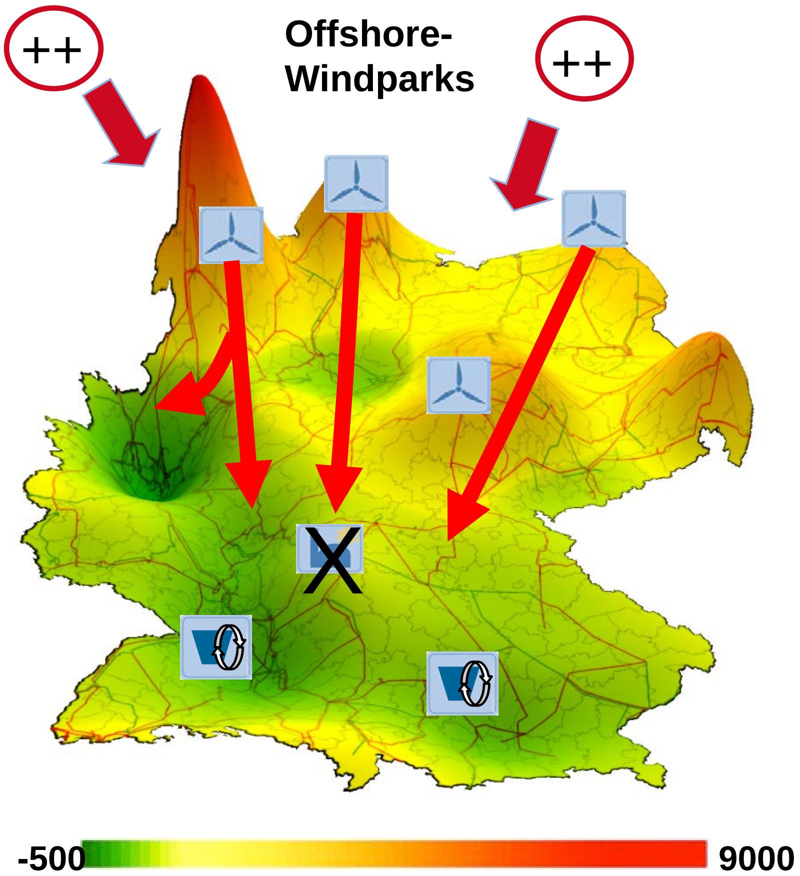
Challenge: Necessary High-Voltage Grid Expansion

- Changing electricity generation landscape: exemplary supply situation
- New generation centers far from load centers

Electricity account balance 2014 [MW]



Electricity account balance 2024 [MW]



2. Grid Development Process

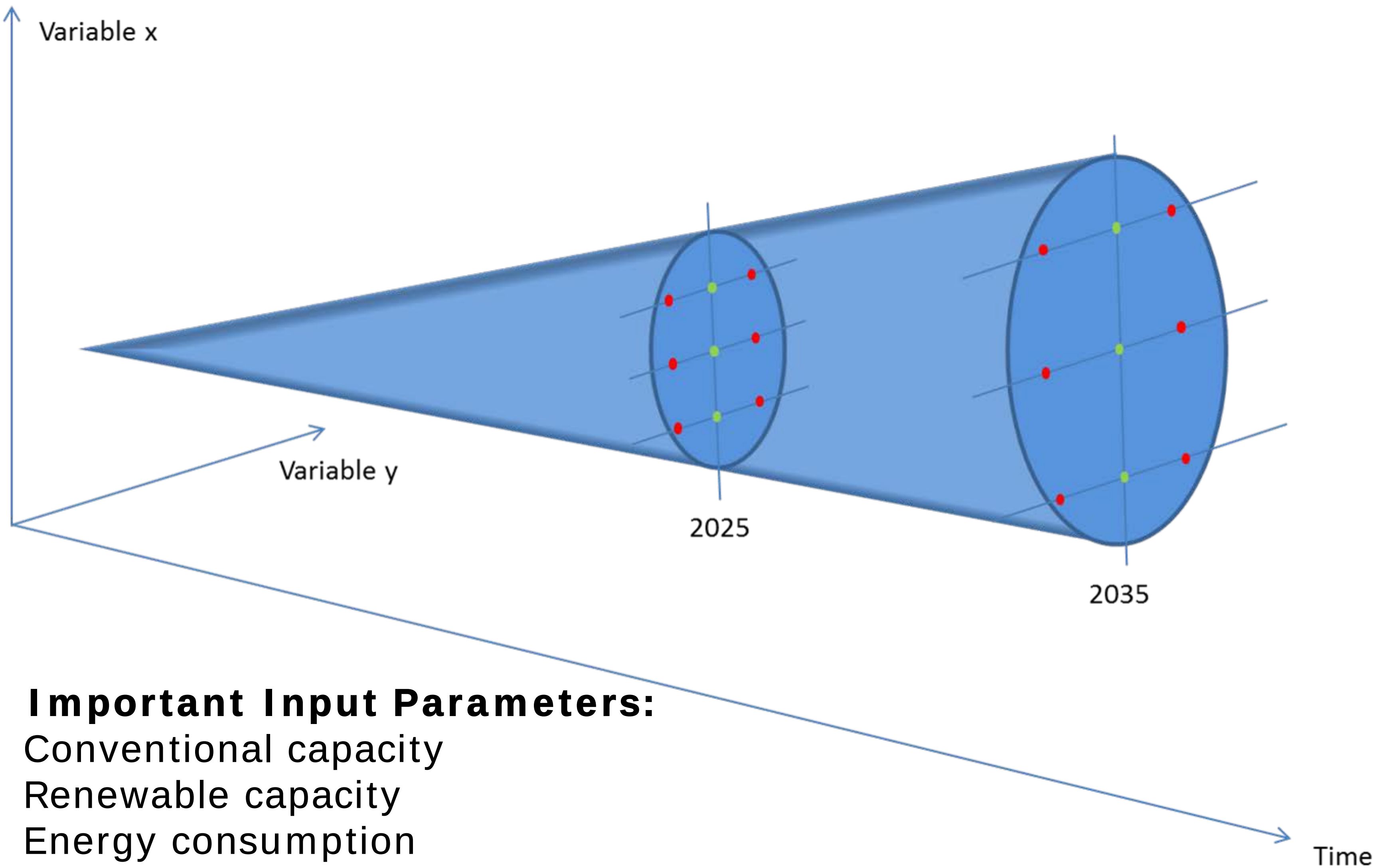
Electricity Grid Planning Process

annual process

I SCENARIO FRAMEWORK	II REGIONA-LIZATION	III MARKET MODELLING	IV POWER FLOW CALCULATIONS	V GRID EXPANSION ASSESSMENT
10 years: scenario A scenario B1, B2 scenario C **20 years:** scenario B1, B2	regional allocation of generation and consumption	simulation of generation and consumption per hour in each electrical grid node	calculations and analysis based on the start-grid	definition of adequate grid reinforcement and expansion projects
How will the energy-system develop over the next 10/20 years?	Where will renewable energies feed in to the grid? (north migration)	Which conventional power plants will cover the remaining load? (fossil fuel mix)	Where and when will the grid be overloaded? (grid bottlenecks)	Which are the right measures? (NOVA-principle, technology selection)

3. Scenario Framework for the Grid Development Plan 2025

Important Input Parameters



Important Input Parameters:

Conventional capacity
Renewable capacity
Energy consumption
CO_2-emission output
European demand/generation

$C0^2$-Emission Output

Scenarios are strongly defined by CO_2-emisson output

Federal Goverments target:

- Decrease of greenhouse gas emissions by 80% in comparison to 1990 (357 million tons) until 2050
- Specific for scenarios:
    - For 2025 decrease of 47,5% to 187 million tons
    - For 2035 decrease of 62,5% to 134 million tons

Federal Goverments target fulfilled					
2025				2035	
A	B1	B2	C	B1	B2
x	x	✓	✓	x	✓

Demand I

Forecast of demand is affected by a large ammount of external parameters

- Increasing effects:
  - Electrification of traffic sector (e-mobility)
  - Electrification of heat sector (thermal pumps, Power to heat)
- Decreasing effects:
  - Energy efficiency by technological advance
  - Efficiency by energy-focused building refurbishment
- Unknown Effect:
  - Demographic change
  - Economic growth

?

Demand II

Federal Goverments target:

Reduction of gross electrical energy demand by 10% in 2020 and by 25% in 2050 in comparison to 2008 (618TWh)

In reference to 2013 (600 TWh) gross electrical energy demand must decrease by 60 TWh until 2025 and by 90 TWh until 2035

General Assumption (all scenarios but C 2025)**:**

Reduction of 30 TWh energy demand is achieved but is neutralized by additional energy demand of traffic sector and heat sector

Assumption for scenario C 2025

Reduction of 60 TWh energy demand. 30 TWh are neutralized by additional energy demand of traffic sector and heat sector

→ Reduction of electrical energy demand (gross and net) by 30 TWh (5% of 600 TWh)

RES expansion corridor is defined in EEG § 1

RES-share of gross electricity consumption:

- 40%-45% in 2025
- 55%-60% in 2035
- ≥ 80% in 2050

Volume expansion by RES-type is defined in EEG § 3:

- Wind-Onshore: +2.500 MW p.a. (net)
- Wind-Offshore: 6.500 MW in 2020 / 15.000 MW in 2030
- Photovoltaics: +2.500 MW p.a. (gross)
- Biomass: +100 MW p.a. (gross)

Renewable Energy Sources II

	2013	2025				2035	
		A	B1	B2	C	B1	B2
RES-share [%]	25,4	41	45,2	45,2	45	61,5	61,5
Wind-onshore [GW]	33,8	53,0	63,8	63,8	59,0	88,8	88,8
Wind-offshore [GW]	0,5	8,9	10,5	10,5	10,5	18,5	18,5
Photovoltaics [GW]	36,3	54,1	54,9	54,9	54,1	59,9	59,9
Biomass [GW]	6,2	6,4	7,4	7,4	6,4	8,4	8,4
Hydropower [GW]	3,9	3,9	4,0	4,0	3,9	4,2	4,2
Other types [GW]	0,4	0,5	0,8	0,8	0,5	1,2	1,2
Total RES [GW]	81,1	126,8	141,4	141,4	134,4	181,0	181,0

Prediction of installed conventional capacity based on the BnetzA „Power Plant Database“

- Assumption of general average lifecycle
- Announced decommissioning are taken in consideration
- Plants under construction are considered in all scenarios
- Lignite plants in planning are not considered
- Hydro storages under construction or in planning are considered in all scenarios

!

Assumption of lifecycle is a flat-rate approach

Profitability of individual plants is not relevant

Longterm business strategy is not predicted

Conventional Energy Sources II

Assumption to general average lifecycle (in years)						
	2025				2035	
	A	B1	B2	C	B1	B2
Lignite	50	45	45	40	45	45
Hard coal	50	45	45	40	45	45
Gas	45	40	40	35	40	40
Oil	45	40	40	35	40	40
Hydro storage	inf	inf	inf	inf	inf	inf
Waste	inf	inf	inf	inf	inf	inf
Other	45	40	40	35	40	40

- Average lifecycle of conventional sources decreases in scenarios with uneconomical conditions
- Impact of CO_2-emisson output restriction will be shown by comparing full load hours in scenarios B1 and B2

Conventional Energy Sources III

	Installed conventional capacity [GW]						
	2013	2025				2035	
		A	B1	B2	C	B1	B2
Nuklear	12,1	0	0	0	0	0	0
Lignite	21,2	14,2	12,6	12,6	10,2	9,1	9,1
Hard coal	25,9	25,8	21,8	21,8	14,9	11,0	11,0
Gas	26,7	26,5	29,9	29,9	29,5	40,7	40,7
Oil	4,1	1,3	1,1	1,1	1,1	0,8	0,8
Hydro storage	6,4	8,6	8,6	8,6	8,6	12,7	12,7
Other	4,7	3,2	3,1	3,1	3,1	3,1	3,1
Sum	101,1	79,6	77,3	77,3	67,4	77,5	77,5

A side note to Market Modelling

Combined Heat and Power generation is simulated by linking electricity and heat sector

For market modelling the behavior of combined heat and power plants is simulated detailed

- **Back-pressure plants:** Energy feed depends on heat demand. Lokal head demand is defined by prescribed temperature time series
- **Public or industrial supply:** Minimal process- and time-dependent production is known.

  Market-driven production ≥ Minimal production

Federal Goverments Target: 20% electrical energy production by combined heat and power plants assumed in all scenarios

Assumption for demand and generation capacities in Europe are required for market modelling

Thus adequate SO&AF scenarios are assigned to scenarios of the scenario framework

Scenario Framework 2025	SO&AF 2014-2030
Scenario A 2025	Scenario A Conservative Scenario
Scenario B1 2025	Scenario B Best Estimate Scenario
Scenario B2 2025	Scenario B Best Estimate Scenario
Scenario C 2025	Scenario B Best Estimate Scenario
Scenario B1 2035	Vision 3
Scenario B2 2035	Vision 3

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Thank you for your attention!

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