Industrial decarbonisation pathways

Options and policies

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- Transition in a disruptive environment
- EU 2050, fit-for-55 and transition of energy intensive industries
- Selection of industrial (climate) strategies around the world
- SWOT for vegetable oil/proteinmeal sector
- Greenhouse gas mitigation options
- Challenges
- Towards an industrial strategy for vegetable oil industries & planning ahead by companies
- How to start…

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4 major challenges in food production value chain

- LAND USE – Biodiversity loss
- CLIMATE CHANGE – impacts on food security
- GEO-POLITICAL
- MITIGATION – achieving climate neutrality in 30 years

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Land use

- Growing population
- Changing diet (meat)
- Biodiversity collapse (incl. pollinating insects) & nature destruction

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Impacts of climate change
• Value chain disruptions
• Food security
• Social unrest

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Geo-political risk
Food as a weapon

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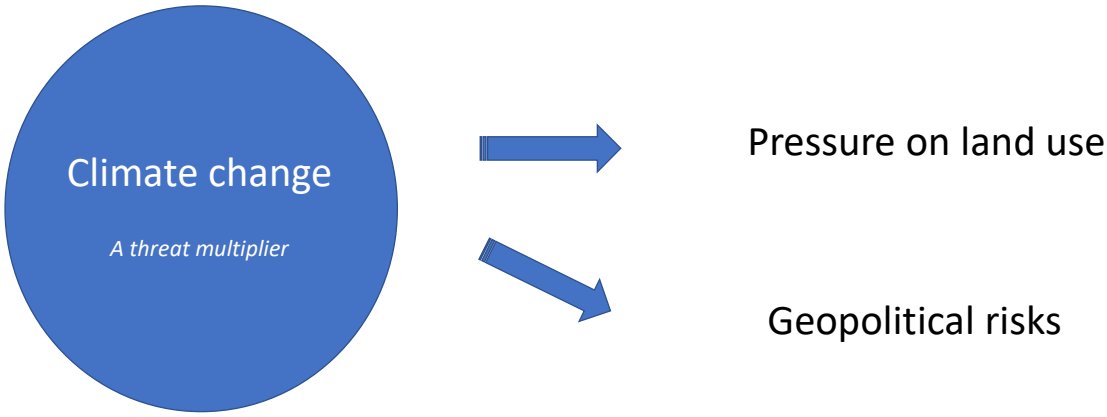

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Towards a net-0 greenhouse gas emissions EU

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EU 2030 targets (updated – fit for 55)

- 55% emission reductions vs 1990
- EU ETS sectors → 61% reduction by 2030 ref. 2005
- Effort Sharing → 40% reduction by 2030 ref. 2005
- At least 40% renewable energy production by 2030
- 39% primary energy savings

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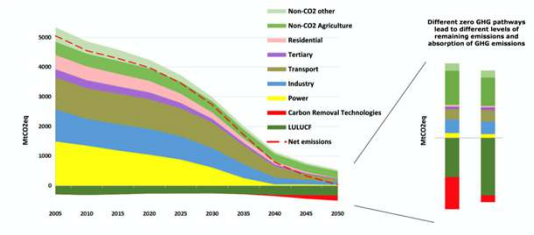
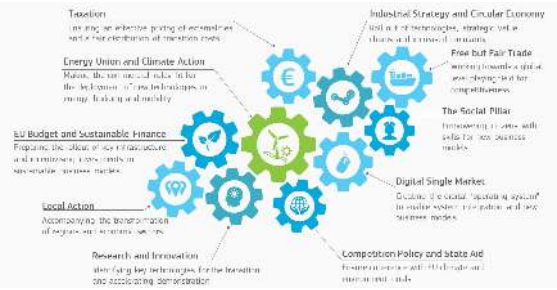


"It's the whole economy"



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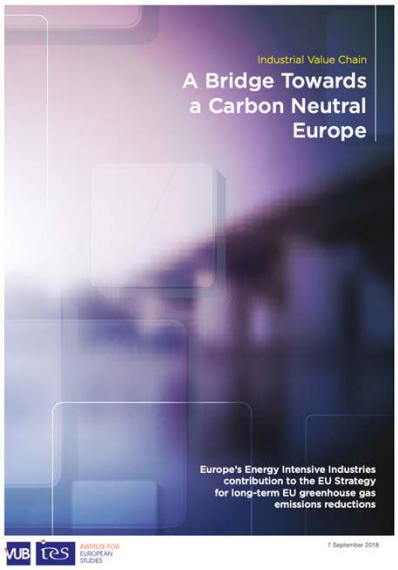

	Electrification (heat and mechanical)	Electrification (processes: electrolysis/ Electrochemistry excl. H2)	Hydrogen (heat and/or process)	CCU	Biomass (heat and feedstock)/ biofuels	CCS	Other (including process integration)
Steel	**xxx**	xx	xxx	xxx	x	xxx	Avoidance of intermediate process steps and recycling of process gases: xxx Recycling high quality steel: xxx
Chemicals fertilizers	xxx	xxx	xxx	xxx	xxx	xxx(*)	Use of waste streams (chemical recycling): xxx
Cement Lime	xx (cement) x (lime)	o (cement) o (lime)	x (cement) x (lime)	xxx (cement and lime)	**xxx** (cement) x (lime)	xxx (cement and lime)	Alternative binders (cement): xxx Efficient use of cement in concrete by improving concrete mix design: xxx Use of waste streams (cement): **xxx**
Refining	xx	o	xxx	xxx	xxx	xxx	Efficiency: **xxx**
Ceramics	xxx	o	xx	x	x	o	Efficiency: **xxx**
Paper	xx	o	o	o	**xxx**	o	Efficiency: **xxx**
Glass	xxx	o	x	o	xxx	o	Higher glass recycling: xx
Non-ferrous metals/alloys	**xxx**	**xxx**	x	x	xxx	x	Efficiency: **xxx** Recycling high quality non-ferrous: xxx Inert anodes: xxx

o: Limited or no significant application foreseen
x: Possible application but not main route or wide scale application
xx: medium potential
xxx: high potential
***xxx**: Sector already applies technology on large scale (can be expanded in some cases)*
(*) in particular for ammonia and ethylene oxide

All energy intensive industries in the EU developed roadmaps and most are working on implementation

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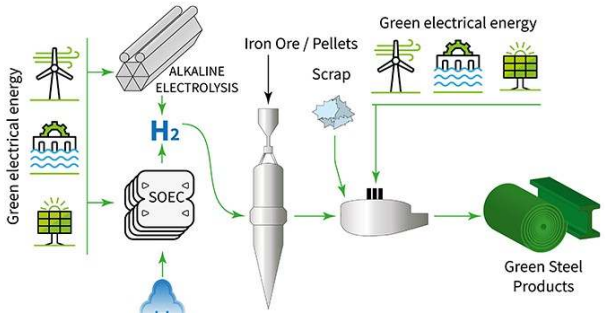

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Industrial transition challenges

- 30 years to net-0 = 1 investment cycle
- Access to affordable, reliable green energy
- Infrastructure for e.g. H2 and CO2
- R&D support esp. towards DEMO/FOAK
- Higher CAPEX/OPEX
- Regulatory misalignment
- Maintaining international competitiveness during transition

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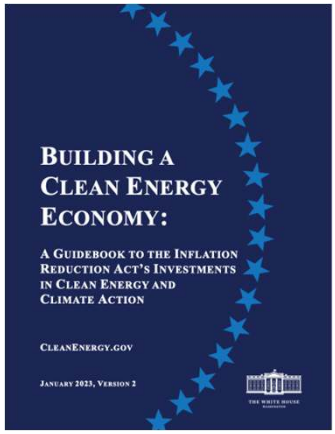
US inflation reduction act (2022)



- **$ 369 Bn support via tax credits, loans & subsidies**
- **Purpose**:
  - Increase demand for green materials and clean-tech
  - Drive innovation via R&D support for clean materials
  - Use public procurement to increase demand for clean products
- **Acces tot cheap clean power**: via tax-credits for investments in H2/RE/Batterijen (Clean Electricity Production Tax Credit, Clean Electricity investment Tax Credit 10y). For producers of wind, sun, battery installations via Advanced Manufacturing Tax Credit (only domestic production), Advanced Energy project Investment Tax Credit for energy producers (30% investment cost) with local procurement (e.g. 100% US steel, 40% US components)
- **Acces to cheap Hydrogen** via Green Hydrogen Production Tax Credit ($3/kg H2 with RE)

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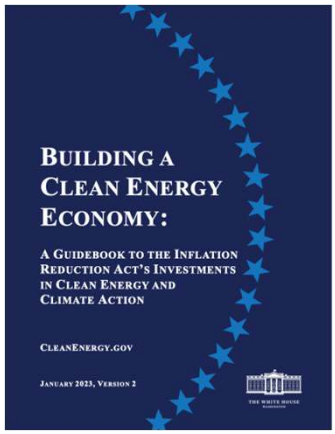
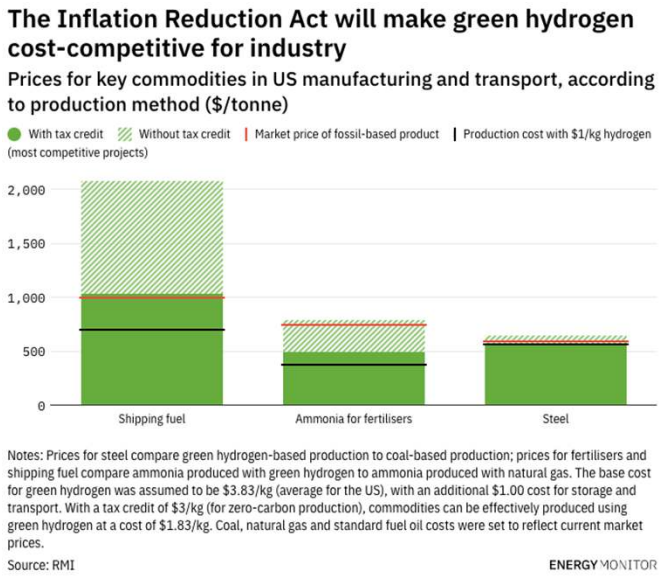
US inflation reduction act (2022)





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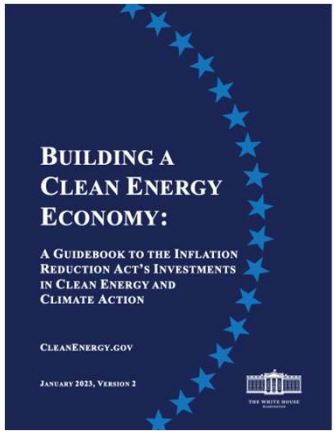
US inflation reduction act (2022)



- **Support for CCUS via tax credits** : $85 per tonne captured/stored // $60 per tonne used. 12y – construction started before 2033
- **Support for Low-CO2 proces-technology**: $ 5.8 Bn for new DOE office of clean energy demonstrations with Advanced Industrial Facilities Deployment (AID): loans, subsidies, … up to 50% of CAPEX.
- **loans**: via EPA Loans Programs Office (LPO) $11.7 Bn for new loans. Total budget $100 Bn ($ 40 Bn for innovative clean energy)
- **Labeling**: $100 miljoen voor development of labels for construction materials with low embedded carbon.
- **Green public procurement**: $ 4.5 Bn extra for Federal Buy Clean Initiative.

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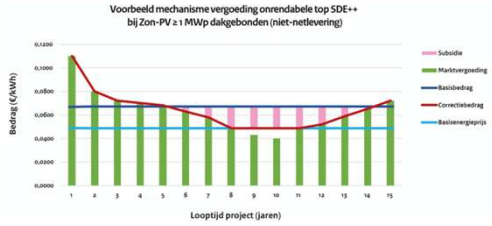
SDE++ Netherlands: Operational subsidy

- Subsidy during use of new installations for period of 12-15y
- Subsidy varies depening on CO2 and (energy) price
- Subsidies for: renewable electricity, gas & heat, low CO2 arme heat & production (as from 2020)
- For industry support for a.o.: biomass use, electrification of heat, CC(U)S
- Subsidy for 'unprofitable' top: for energieproduction dependent on energieprices, for ETS installation dependent on CO2 price (EUA's).



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SDE++ Netherlands (2023)

- EUR 8 Bn available for 2023 (+3 Bn compared to previous round. Could lead to 4 Mt CO2 reduction)
- Earmarking part of budget via minimum budget per category (Eur 750 Mn for low T heat, high T hear & (green) molecules). Max. subsidy to 400 EUR/t for these 3.
- Competitive element via application rounds with higher savings cost (EUR/t CO2). Most cost effective come first but earmarking ensures budget for more expensive tech.

Openstellingsronde SDE++ 2023	Fasegrenzen €/ton CO_2
6 juni	90
12 juni	180
19 juni	240
26 juni	300
3 juli	400

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EU: Innovation fund, IPCEI, Net-0 industry act

- **EU ETS Innovation Fund:**
  * >40 BN EUR budget until 2030 (industry, innovative RE/CCS and H2)
  * 60% of relevant (extra) costs (CAPEX + OPEX) linked to innovation are supported. Partialy ex-ante via milestones to be achieved
  * Very competitive 1/30 succes rate
  * Synergy with Invest EU: Green Transition Thematic Product (high risk EIB funding) // EU breakthrough Energy Catalyst (BEC)
  * Future support for competitive tendering mechanisms (e.g. CfD) – focus on H2 (3 Bn EUR)
- **IPCEI (hydrogen**): EUR 5.4. miljard state aid approved. 13 MS, 35 projects, 29 companies. Technology & infrastructure support.
- **Net-0 industry act**: Relevant for industry in particular wrt heat-pumps, bio-gas, CCS. Simplifying permiting, Regulatory sandboxes, target CO2 storage, green procurement, skills, job-creation & education, EU coordination of support, …

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France, Germany, UK higlights

- **French** "2030 recovery" program with support for a.o. energy transition and environmental protection. EUR 30 Bn over 5 year.
- **German** industrial transition 2030 plan: focus on new technologies, CCUS, Hydrogen, bio-economy…
- **German** initiatives on (carbon) contracts for difference and support for dealing with high electricity prices
- **UK industrial strategy**: higher R&D investment (2.4% GDP), worlds first net-0 industrial cluster by 2040, Industrial strategy challenge fund (170 Mn GBP)

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Strengths

- Production process experience and know-how
- Diversification in raw materials supply
- Well developed logistics and value chains
- EU internal market

Weaknesses

- Energy prices/costs
- Low margins
- Limited innovation (support)

Threats

- Climate disruption
- Geopolitical disruption
- Radical/fast Regulatory changes (e.g also scope 2 emissions)
- Other regions around the world with more generous industrial strategy/policies

Opportunities

- Use innovations from other industries
- Deepen sector focussed innovation in EU
- Broaden raw materials range
- Tap into newer markets (higher value added)
- Find energy synergies with other industries (e.g. use of waste heat)

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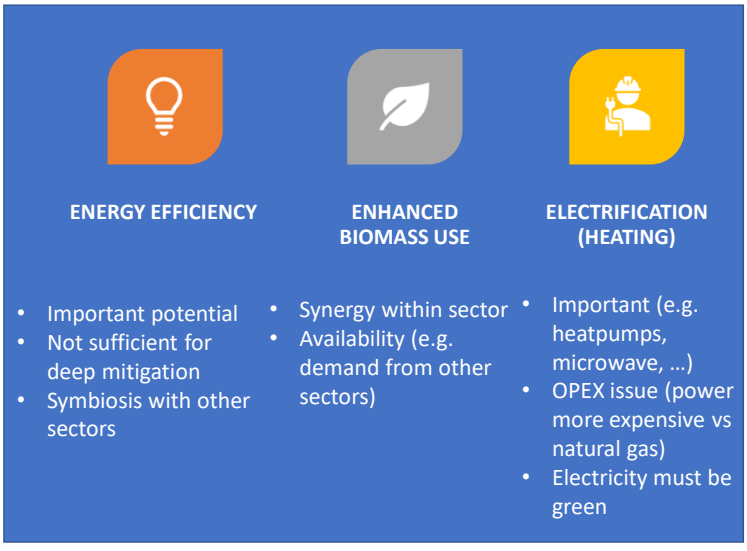
Greenhouse gas mitigation options



ENERGY EFFICIENCY

- Important potential
- Not sufficient for deep mitigation
- Symbiosis with other sectors

ENHANCED BIOMASS USE

- Synergy within sector
- Availability (e.g. demand from other sectors)

ELECTRIFICATION (HEATING)

- Important (e.g. heatpumps, microwave, …)
- OPEX issue (power more expensive vs natural gas)
- Electricity must be green

HYDROGEN

- Possible but …
- Infrastructure challenge for remote locations

CARBON CAPTURE, UTILISATION AND STORAGE

- Capture and transport Infrastructure challenge for remote locations/small plants
- Utilisation can become option

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Strategic mitigation approach for e.g. seed crushing, crude oil refining
Focus on electrification

- High heat demand but relative low temperatures (e.g. < 260C)
- Important to further lower T and heat demand in crushing, bleaching, degumming, …
- R&D in advanced heating technologies (e.g. microwave, radio frequency, advanced ultrasonic, …)
- Electrification must lead to higher overall efficiency (condition) → aim factor 2
- Industrial heatpumps are coming to market (+40 MW) but high CAPEX (and OPEX depends on power price)
- Industrial energy symbiosis can be major options (e.g. low T waste heat from chemicals industry)
- With electrification scope 2 emissions become more important → securing green PPAs
- Research needed into demand response options (to meet variable RE sources)

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Barriers and challenges for transition of vegetable oil and proteinmeal industry in EU

R&D CHALLENGES: EFFICIENCY TECHNOLOGIES AND ADVANCED ELECTRIFICATION TECHNOLOGIES TO BE ADDRESSED ASAP

INVESTMENT CHALLENGE: HIGH CAPEX, BROWNFIELD CONVERSION ESP. ISSUE FOR SME'S

OPEX: HIGH ELECTRICITY PRICES STIFLE ELECTRIFICATION

INFRASTRUCTURE NEEDS E.G. HEAT NETWORKS, SHARED HEATPUMPS, …

RISK SHARING FRAMEWORK FOR INDUSTRIAL SYMBIOSIS

LOCATION DISADVANTAGE FOR COMPANIES WITHOUT OPTION FOR WASTE HEAT USE, SYMBIOSIS, LIMITED GREEN ELECTRICITY

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Industrial strategy *concept*

- DEDICATED R&D ADVANCED, HIGHLY EFFICIENT CRUSHING AND REFINING TECHNOLOGIES
- FURTHER R&D FOR NEW ELECTRIFICATION TECH.
- FACILITATE ACCESS TO LOW-T HEAT INDUSTRIAL (SYMBIOSIS) INFRASTRUCTURE: MAP NEEDS AND START CONSTRUCTION
- CAPEX SUPPORT FOR INVESTMENTS E.G. FIRST LARGE INDUSTRIAL HEATPUMPS
- OPEX SUPPORT IN PARTICULAR MEASURES TO REDUCE ELECTRICITY COSTS

Technologies must be market ready by 2030, infrastructure deployment advanced by same date

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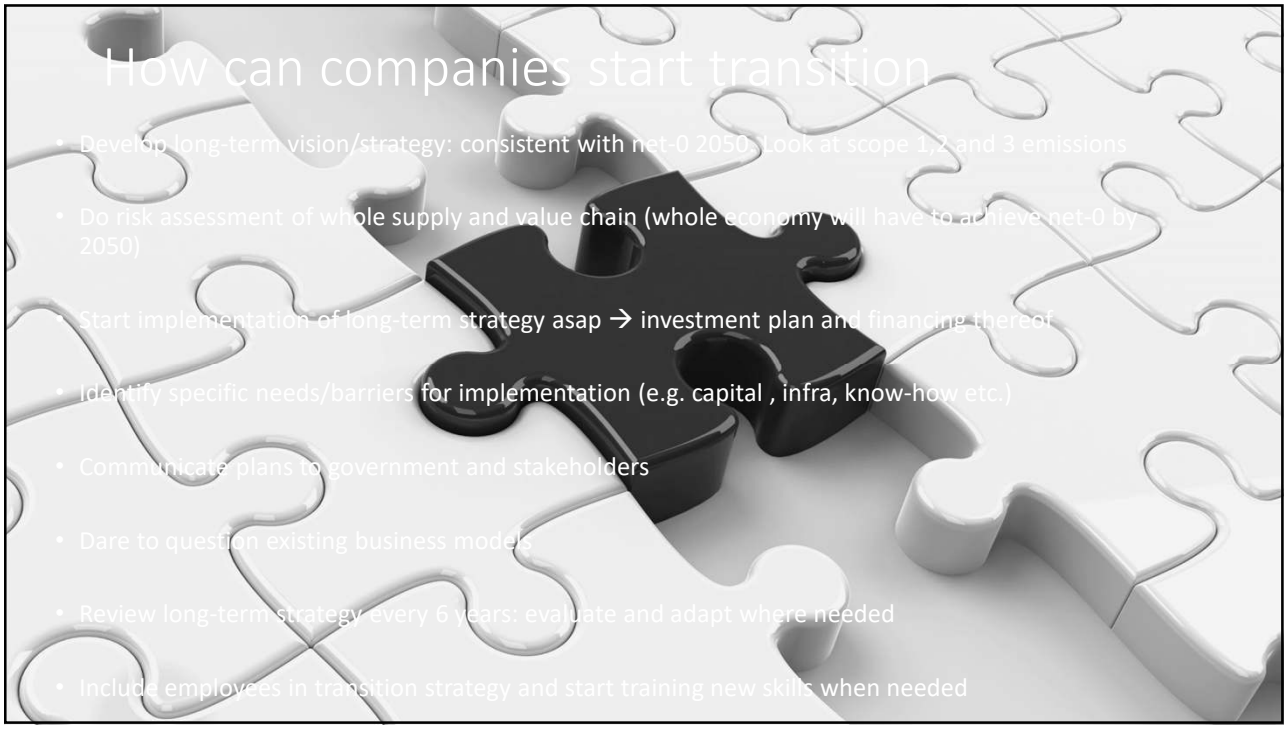

How can companies start transition

- Develop long-term vision/strategy: consistent with net-0 2050. Look at scope 1,2 and 3 emissions
- Do risk assessment of whole supply and value chain (whole economy will have to achieve net-0 by 2050)
- Start implementation of long-term strategy asap → investment plan and financing thereof
- Identify specific needs/barriers for implementation (e.g. capital , infra, know-how etc.)
- Communicate plans to government and stakeholders
- Dare to question existing business models
- Review long-term strategy every 6 years: evaluate and adapt where needed
- Include employees in transition strategy and start training new skills when needed

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