TARGETING GHG REDUCTION INSTEAD OF RENEWABLE DEPLOYMENT

THE DUTCH SDE++ SCHEME

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Innovative solutions in designs and their implementation possibilities in the ENC contracting parties

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Overview of the Dutch RES support schemes

General concept:

- Auction-based allocation of the predefined support **budget**
- Operating subsidy to compensate the unprofitable component (**feed-in premium**)
- **Technology inclusivity** (not neutrality): continuous expansion of eligible technologies

MEP (2003-2006)

- Renewable electricity

SDE (2008-2010)

- Renewable electricity
- **Renewable gas (2010-)**

SDE+ (2011-2020)

- Renewable electricity
- Renewable gas
- **Renewable heat (2016-)**

SDE++ (2020-)

- Renewable electricity
- Renewable gas
- Renewable heat
- **Low-CO_2 heat**
- **Low-CO_2 production**

renewable electricity — *renewable energy* — ***CO_2 reduction***

Focus of the presentation: the transition from RES generation to CO_2 reduction

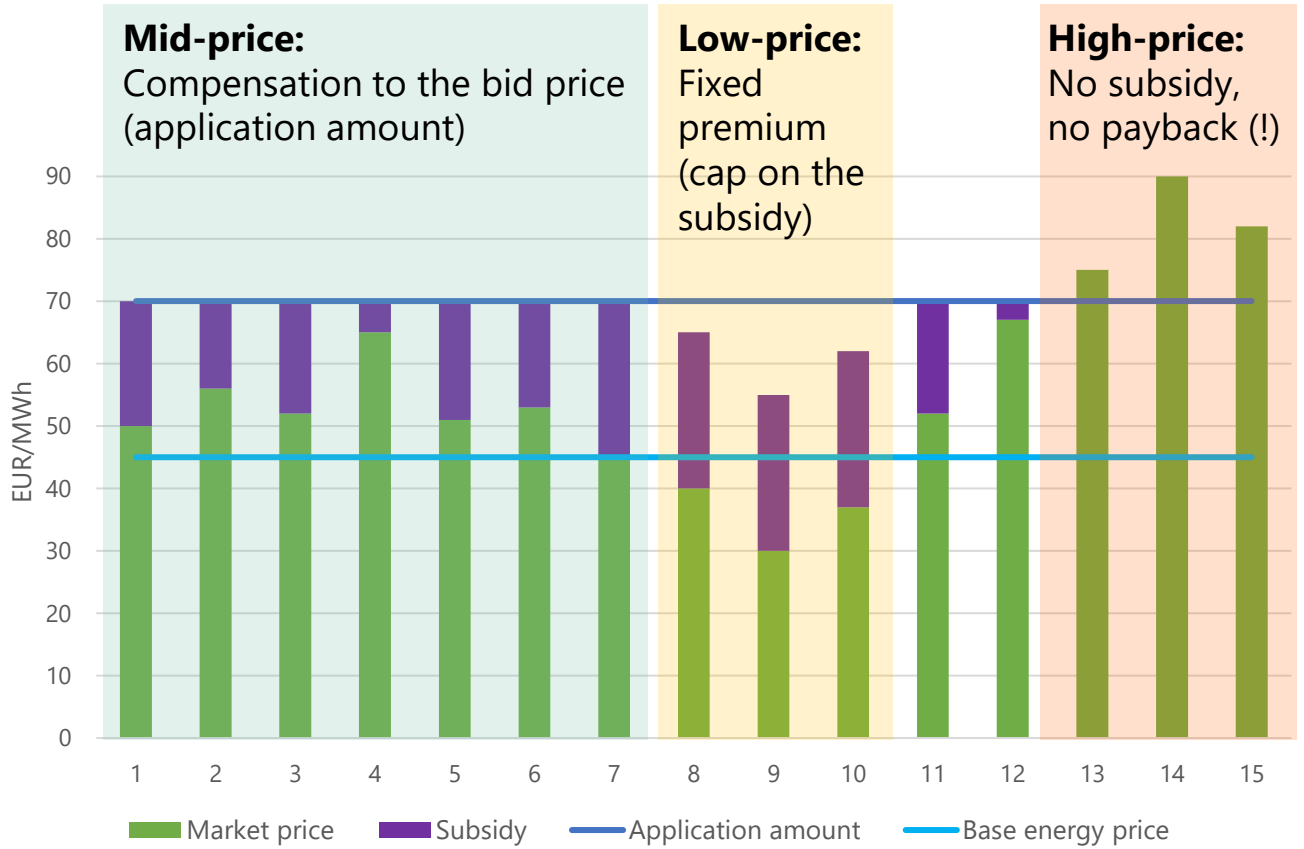
- Where from? – The outline of the SDE+ system
- How to? – The main methodological differences
- What for? – Results and experiences
- What's next? – Latest and planned amendments

Where from? – The outline of the SDE+ system

Technology inclusive allocation of the support budget

- Technology specific (cost-based) ceiling prices:
  - administrative cap on the subsidy
  - possibility for indirect promotion of less efficient technologies
- Remuneration scheme: 1-sided sliding premium →
  - cap on subsidy (if market price is low)
  - possibility of oversubsidization
- The allocated budget limit is the maximum (theoretical) subsidy expenditure:
  - If the market price is below the basic level and the production is at the maximum (predefined subsidized) level
  - In other cases, the budget is not fully used

Illustration of the Dutch premium scheme



How to? – Eligible technologies in the SDE++ system

Main category	Technology
Renewable electricity	Osmose
	Hydropower
	Wind
	Solar PV
Renewable gas	Biomass fermentation
	Biomass gasification
Renewable heat	Biomass fermentation
	Biomass gasification
	Composting
	Solar thermal energy
	Geothermal energy

Main category	Technology
Low carbon heat	Aquathermal energy
	Air-water heat pump
	Daylight greenhouses
	Solar PVT panels with heat pump
	Electric boilers
	Geothermal energy with heat pump
	Waste heat utilisation
	Industrial heat pump
Low-carbon production	Electrolytic hydrogen production
	Carbon capture and storage (CCS)
	Carbon capture and use in greenhouse horticulture (CCU)
	Advanced renewable fuels

NEW TECHNOLOGY CATEGORIES ADDED IN 2020

Need for change in the methodology

- Practical consideration: Technologies are comparable only based on a common unit (kWh vs. tCO_2)
- Essential consideration: CO_2 reduction matters (not the generated energy)

Source: SDE++ Brochure, 2023 (english.rvo.nl/sites/default/files/2023-09/BrochureSDE2023English.pdf)

How to? – Methodological issues in a CO_2 –based scheme

Ranking based on subsidy intensity of CO_2 reduction

- All categories except CO_2 capture and storage(CCS) and CO_2 capture and utilization (CCU):

$$Subsidy\ intensity\ [EUR/tCO_2] = \frac{application\ amount\ [EUR/kWh] - long\text{-}term\ price\ [EUR/kWh]}{emissions\ factor\ [kg\ CO_2/kWh]\ /\ 1{,}000}$$

- CO_2 capture and storage (CCS) and CO_2 capture and use (CCU):

$$Subsidy\ intensity\ [EUR/tCO_2] = \frac{application\ amount\ [EUR/tCO_2] - long\text{-}term\ price\ [EUR/tCO_2]}{emissions\ factor\ [kg\ CO_2/tCO_2]\ /\ 1{,}000}$$

Calculating the emission factors per technology: how much CO_2 is avoided by generating energy?

- The actual emission factor changes continuously:
  - In case of renewable electricity generation, the replaced generation depends on many factors (demand, merit order, import/export)
- Generic assumptions made based on in-depth modelling:
  - „When generating renewable electricity, the CO_2 reduction is calculated on the basis of replacing the average CO_2 emissions of an efficient modern gas-fired power station." (high priced hours)
  - Different emission factors for PV and wind as they produce electricity in different hours (allows to differentiate based on the real contribution to decarbonization, 1 kWh ≠ 1 kWh)

How to? – Methodological issues in a CO_2 –based scheme

Examples / Low-cost technologies

Ranking and phasing at maximum base amount categories SDE++ 2023

Category	Subsidy intensity[1] €/ton CO_2 reduction[2] A=(B-C)/D	Base amount €/unit product[2] B	Long-term price €/unit product[2] C	Emission factor kg CO_2/unit product[2] D
Phase 1				
Solar-PV ≥ 1 MWp, building-related (net = 50%)	-148,194	0.0804	0.0923	0.0803
Solar-PV ≥ 1 MWp and < 20 MWp, sun following on land	-145,000	0.0633	0.0749	0.0800
Solar-PV ≥ 20 MWp, sun following on land	-140,000	0.0602	0.0714	0.0800
Solar-PV ≥ 15 kWp and < 1 MWp connection > 3*80 A, building-related (net = 50%)	-108,344	0.0916	0.1003	0.0803

Medium-cost technologies

Deep geothermal energy, conversion of existing oil and gas wells ≥ 20 MWth, base load (6000 full load hours)	27,463	0.0471	0.0350	0.4406
All-purpose fermentation extended lifespan, heat	27,876	0.0679	0.0616	0.2260
CCS - Full CO_2 storage at existing installations, liquid transport, new liquefaction installation	30,106	146,1369	118,9267	903,8220
CCS - New pre-combustion CO_2 purification, existing installation, gaseous transport	30,819	146,9185	118,9267	908,2620

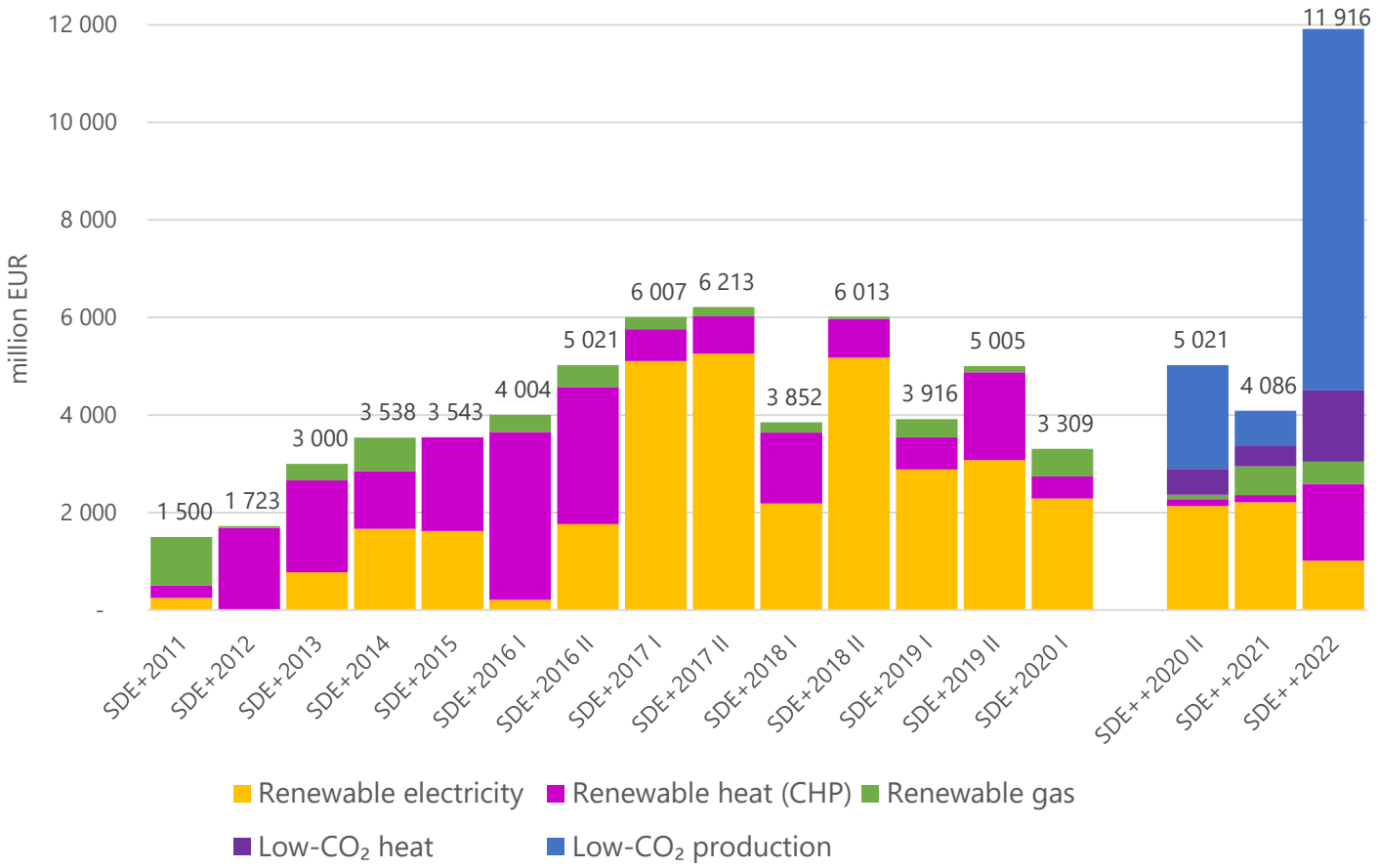
High-cost technologies

Industrial closed heat pump (3000 hours)	323,422	0.0970	0.0350	0.1917
Air-to-water heat pump, heating of existing objects in the built environment	342,091	0.1241	0.0616	0.1827
Sewage treatment plant improved sludge digestion, gas	381,421	0.1148	0.0450	0.1830
Industrial open heat pump (3000 hours)	395,404	0.1176	0.0350	0.2089
Aquathermal energy, thermal energy from surface water, drinking water or sea water, with seasonal storage, heating built environment (6000 full load hours)	399,783	0.1086	0.0350	0.1841

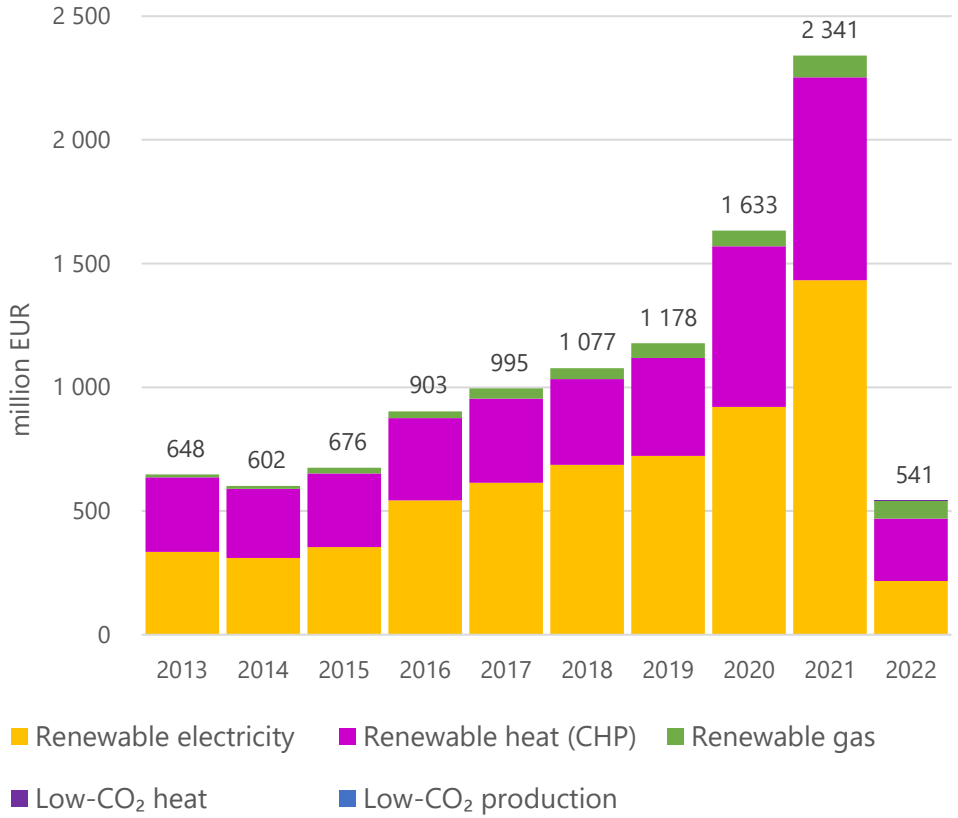
Source: SDE++ Brochure, 2023 (english.rvo.nl/sites/default/files/2023-09/BrochureSDE2023English.pdf)

What for - Results and experiences

Allocated (maximum) budget in SDE+(+) schemes (2011-2022)



Realized cash expenditures (MEP, SDE schemes)



- High diversity of subsidized technologies
- 2017-2020: dominance of 'Renewable electricity'
- In SDE++: The largest share is allocated to ‚Low CO_2 production'

- Much lower actual expenditures compared to the allocated budget
- Sharp shrinkage in 2022 (high prices)

What's next? - Latest and planned amendments

2023: Domain fencing

- Reserved budget for three technology categories ('domains') → BUILDING SECTOR
- 750-750 million EUR (total budget max. 8 billion EUR)

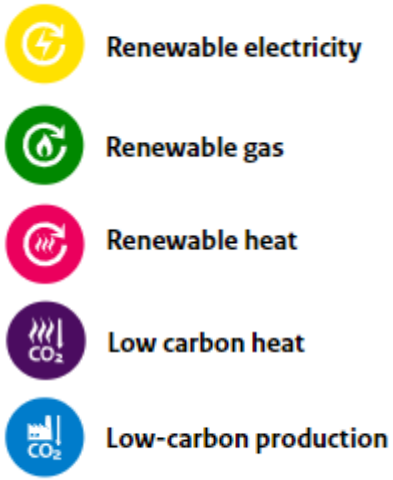
High temperature heat
Biomass combustion
Biomass fermentation
Ultra-deep geothermal energy
Industrial heat pump (open)
Electric boiler

Molecules
Biomass fermentation techniques (renewable gas)
Biomass gasification
Hydrogen from electrolysis
Advanced renewable fuels

Low temperature heat
Biomass fermentation techniques (re. heat)
Composting
Solar thermal energy
Deep geothermal energy
Geothermal energy with heat pump
Aquathermal energy
Air-to-water heat pump
Solar PVT with heat pump
Daylight greenhouse
Industrial heat pump (closed)
Residual waste heat utilisation

Modified remuneration schemes to avoid oversubsidization

- **2024:** In case of oversubsidization, lower subsidized production is set for the next year
- **PV & Wind**: Plans for exclusion from SDE (2025-), further support in a CfD-based scheme (if any)



Summary and conclusions

Benefits of technology inclusivity

- Enhances **cost-efficiency** by facilitating competition between various technologies
  → minimize the support expenditure
- Concentrate on **higher level goals**:
  1. Renewable electricity (instead of PV/wind)
  2. Renewable energy (instead of electricity/heat/gas)
  3. **Decarbonization** (instead of renewable energy)
- **Simplifies the institutional framework**: expansion of an established (and successful) system instead of creating new subsidy schemes for every technology
  → increase **transparency, predictability**

Drawbacks of technology inclusivity

- Fully neutral schemes may lead to **undesired outcomes**
  - Dominance of one technology, does not facilitate the development of less mature technologies
  - Oversubsidization of the most efficient technology
- Solving these problems requires a **more complex** subsidy scheme (e.g. technology-specific ceiling prices)
- Some areas (e.g. building sector) may require to use even more **special treatment** such as domain fencing
- Inclusion of non-energy technologies requires the use of **emission factors** and monitoring of production (Low-CO_2 production)

Conclusions for EnC countries

- Step-by-step approach to include technologies
  (start with the mature renewable technologies – PV and wind)
- Establish a transparent and predictable support scheme with regular auction rounds; this can be further expanded and developed later