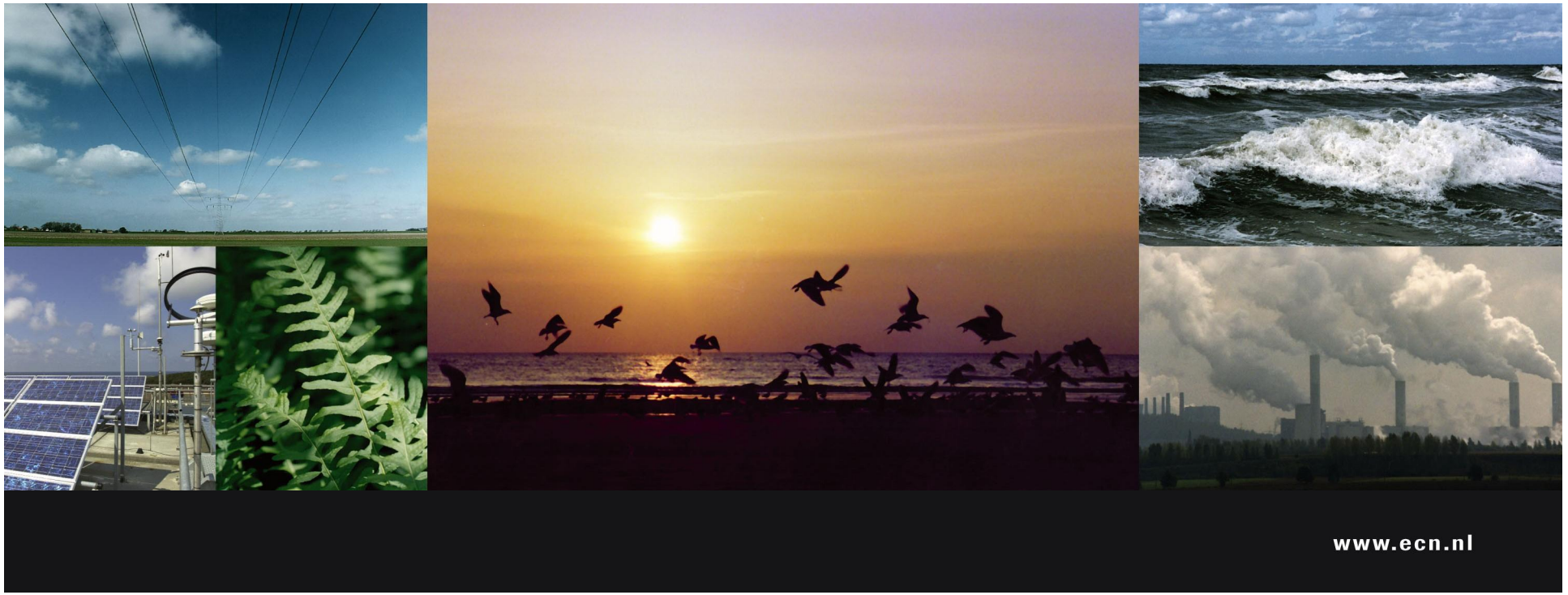
ECN

Energy research Centre of the Netherlands

Application of DG-RES (μ-CHP, PV) and demand response survey in the Netherlands

René Kamphuis, ECN, Petten, the Netherlands



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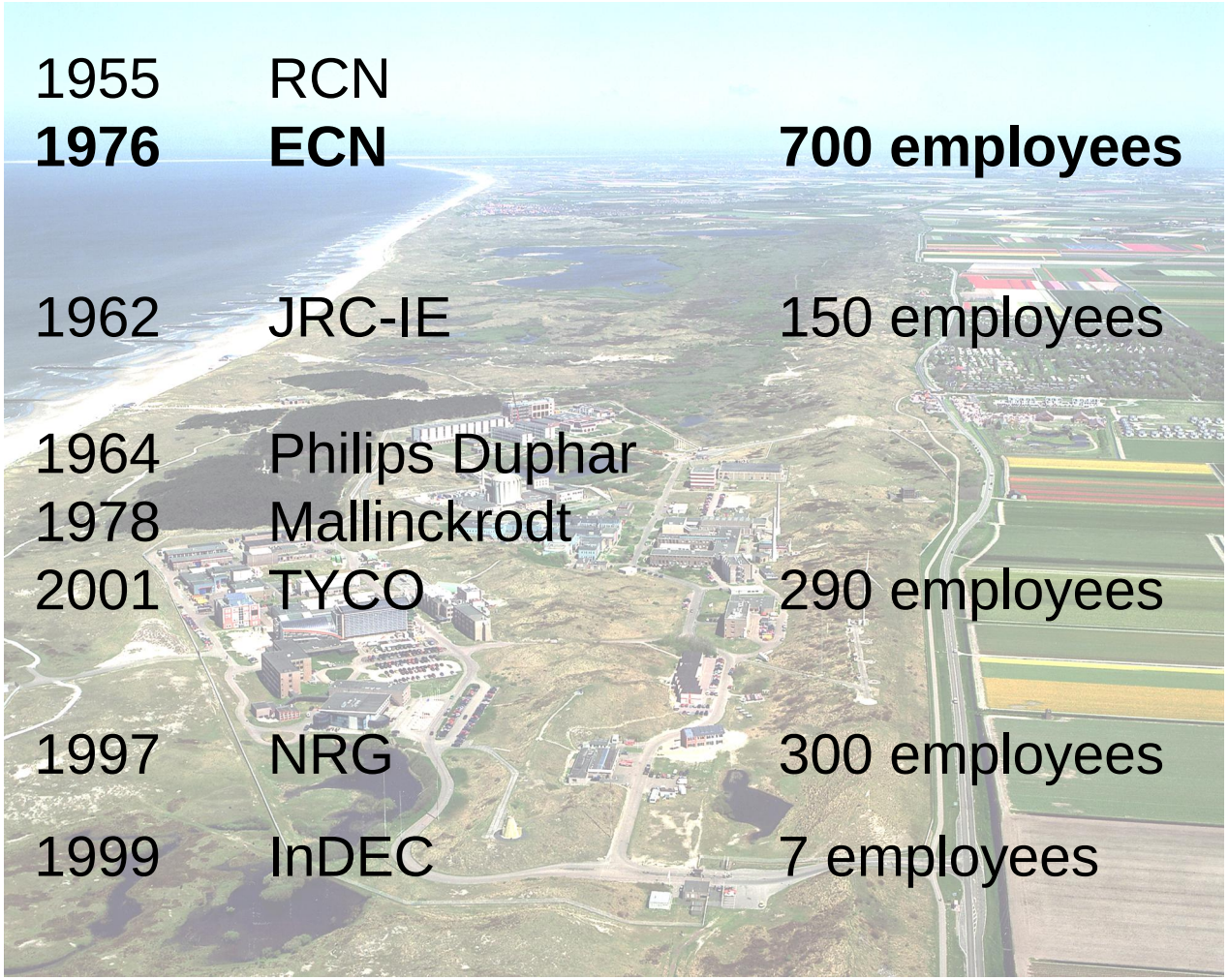
- Introduction ECN
- Market context of the Netherlands
- Dutch distributed generation scenarios
- Demand response inventory studies: industry and domestic
- Future: Distributed Generation, Demand Response and Storage

The Petten site

Companies at the Petten site

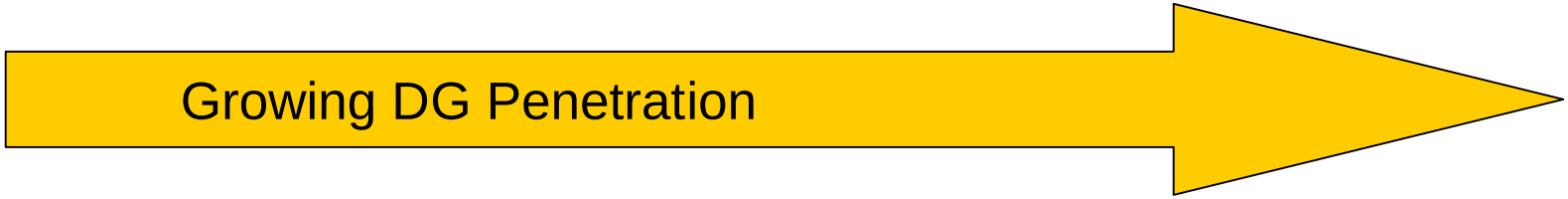


1955	RCN	
1976	**ECN**	**700 employees**
1962	JRC-IE	150 employees
1964	Philips Duphar	
1978	Mallinckrodt	
2001	TYCO	290 employees
1997	NRG	300 employees
1999	InDEC	7 employees

ECN's targets

- ECN is partner of the business community for the development and implementation of products, processes and technologies, which are important for the transition to a sustainable energy supply.
- ECN co-operates intensively with Dutch and foreign universities and R&D organisations.
- ECN concentrates on the knowledge and information demand of the government for policy preparation and evaluation and for the realisation of policy goals in the fields of energy, environment and technological innovations.

ECN vision on SmartGrids: Three stages of DG Growth



Accomodation

- DG accommodated in the current system
- DG units running free
- DG treated as negative demand
- Central control unchanged

Decentralization

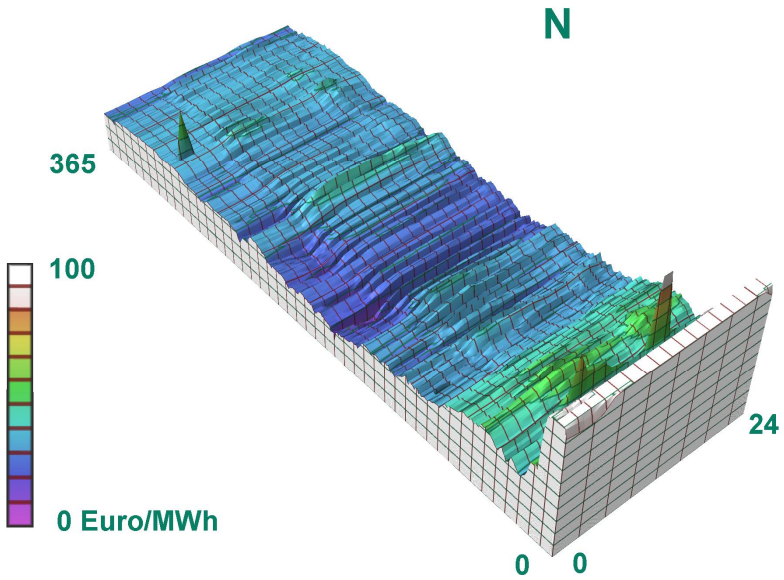
- Added value of clustered control of DG.
- Common ICT systems: Virtual Utilities, Virtual Power Plants.
- Central control still needed
- Decentralized, bottom-up control is added.

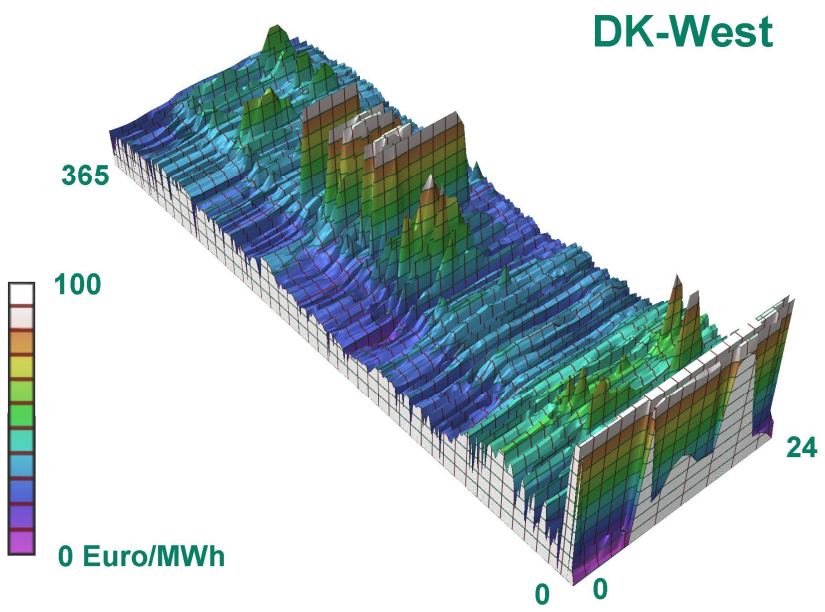
Dispersal

- Distributed power dominates the market
- Network of networks
- Local network segments self-supplying.
- Central controller becomes a coordinator.

Source: IEA, 2002

Fingerprinting market contexts: the NORDEL and Western Danish system

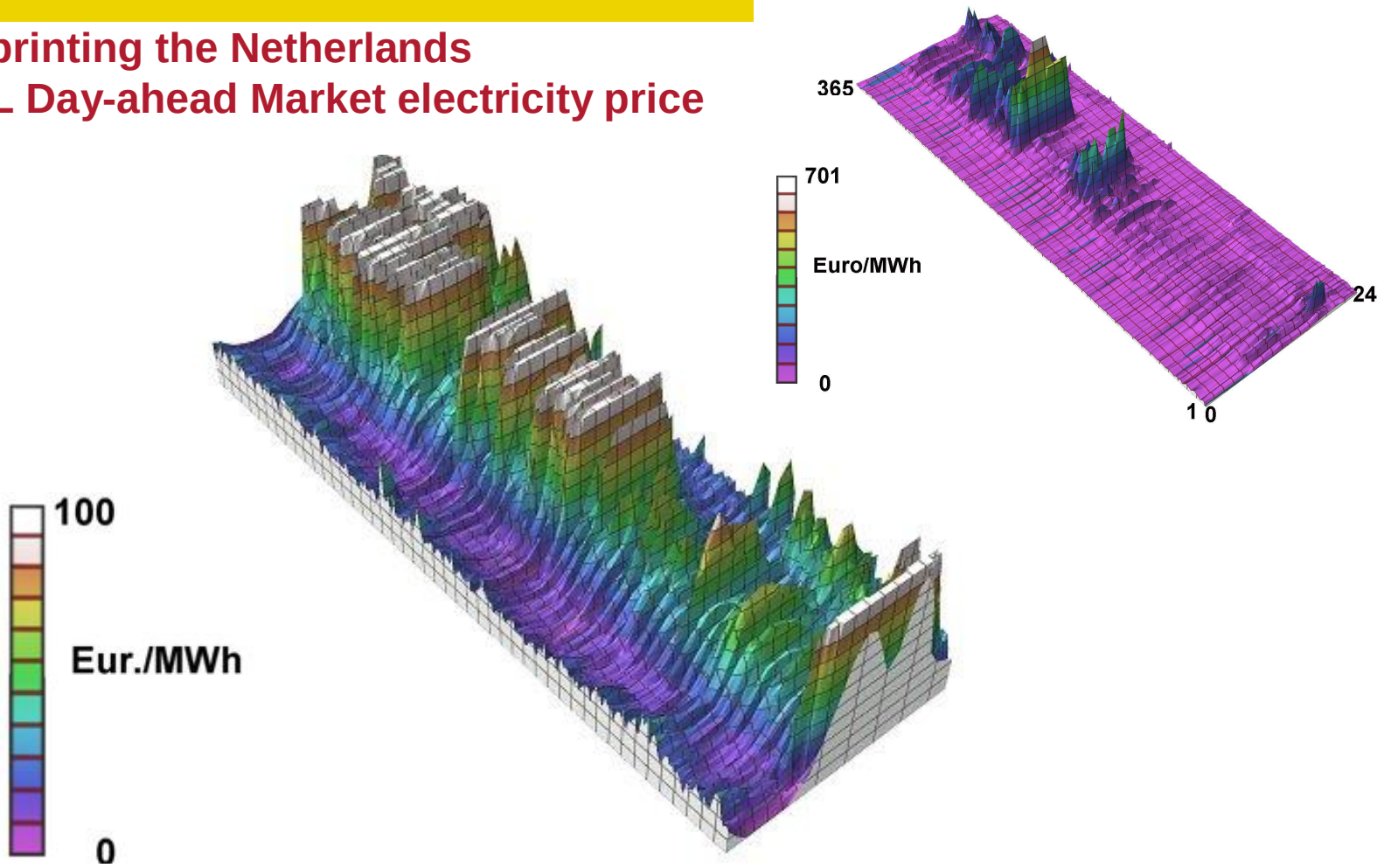




Hydro in winter exhausted
After dry summer

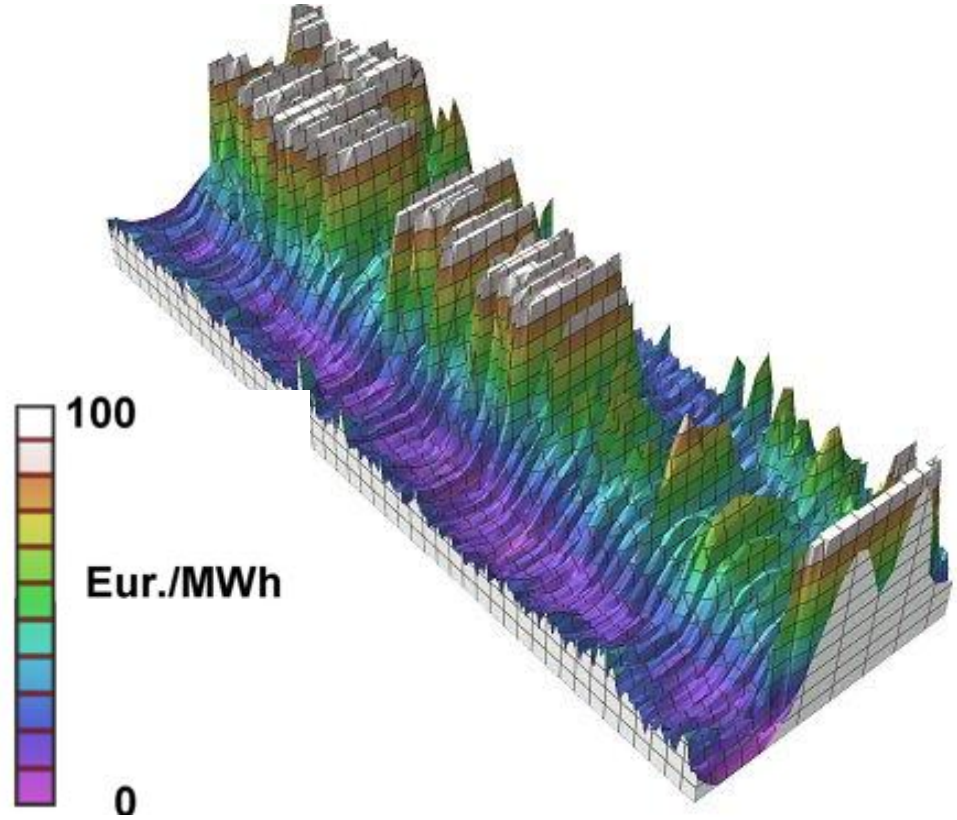
Connected to N-system
Summer wind-deficit

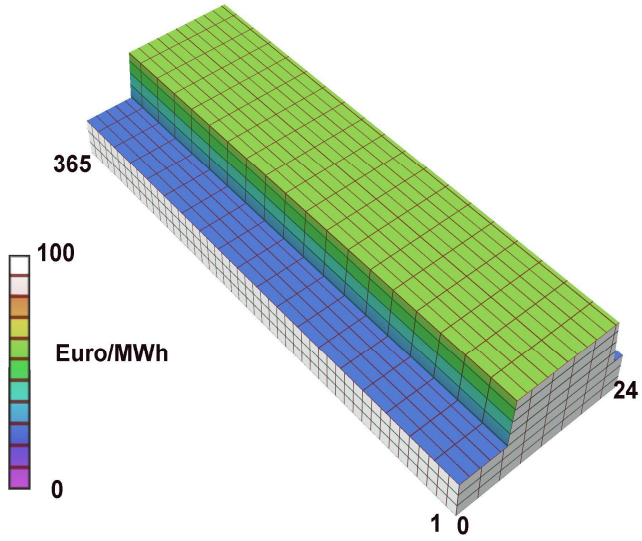
Fingerprinting the Netherlands
APX-NL Day-ahead Market electricity price



- 10-15 hour peak in summer
- 16-18 hour peak in winter

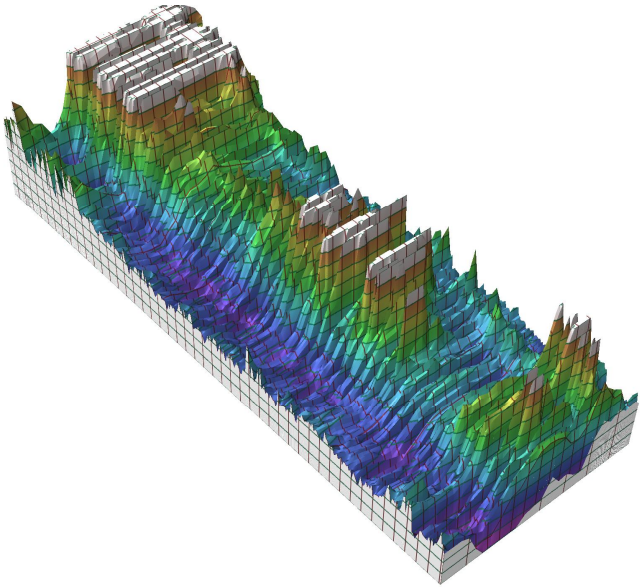
Fingerprinting the Netherlands
End-user two-tariff electricity price

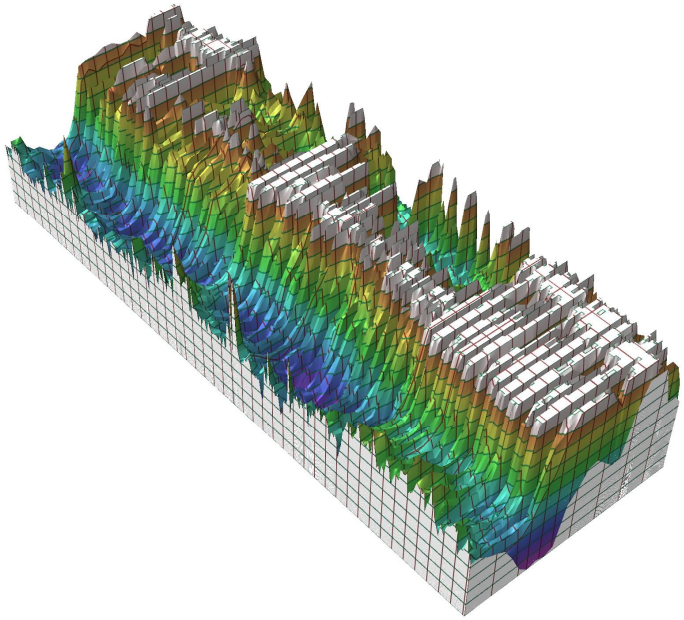


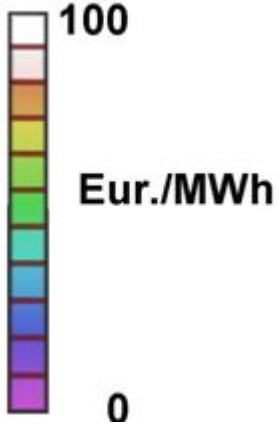


- 10-15 hour peak in summer
- 16-18 hour peak in winter

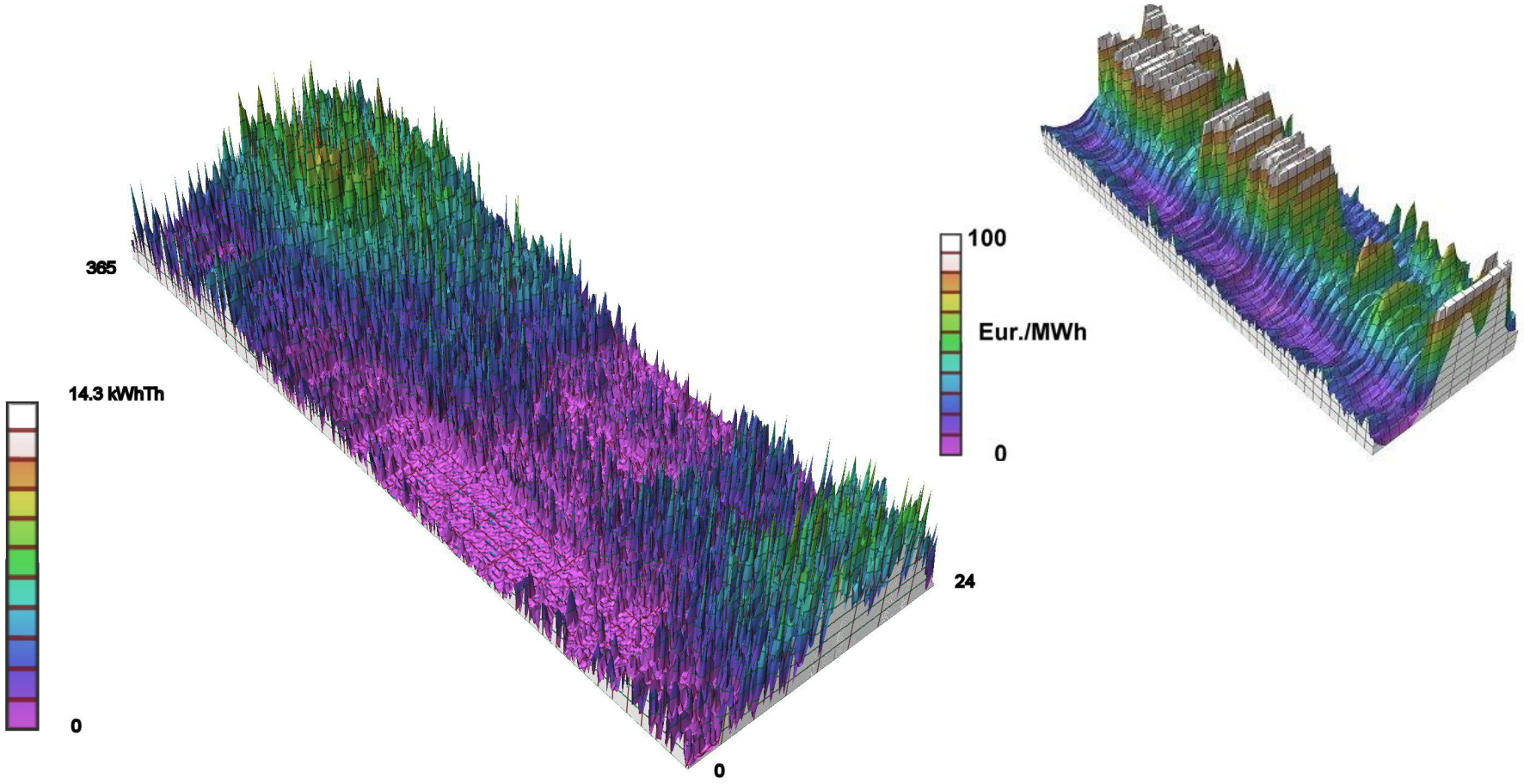
the Netherlands 2006 -2007
APX-NL Day-ahead Market electricity price





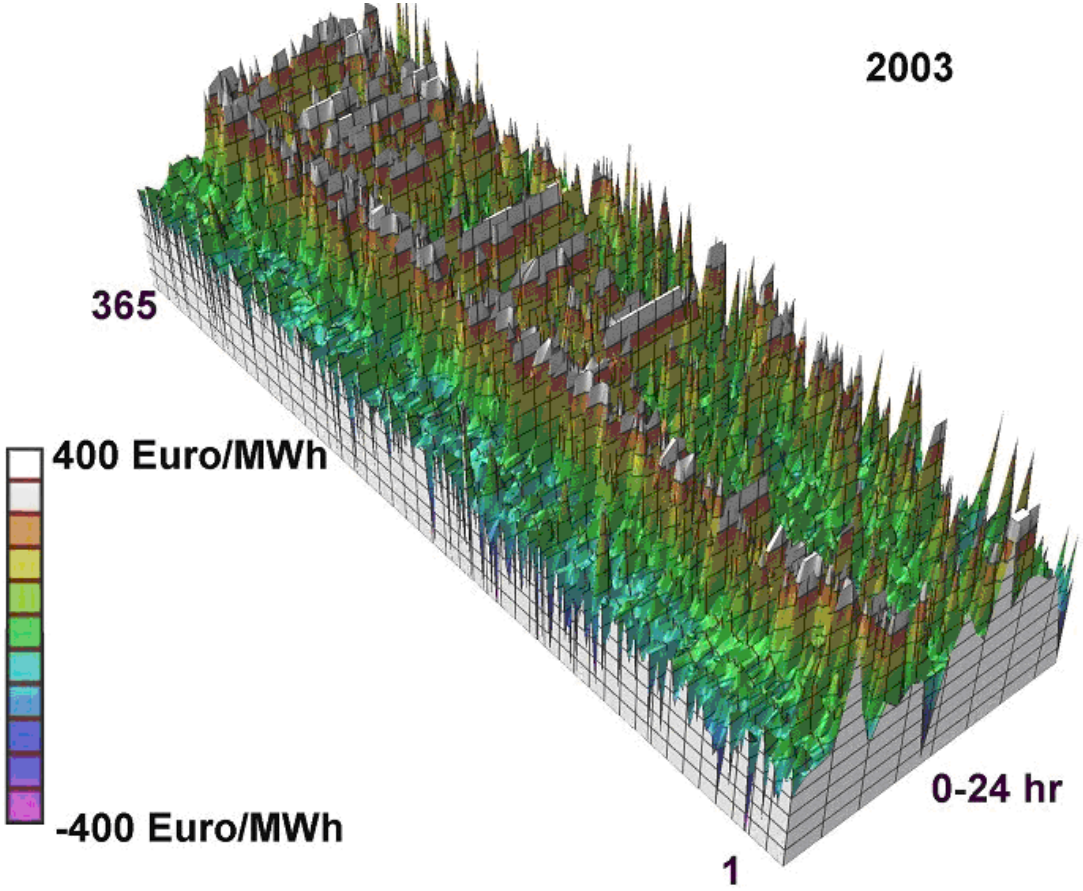


Fingerprint-3: 8 Dutch homes measured heat demand



Heat demand following µCHP co-generates at peak prices

Fingerprinting-4 : Imbalance Market electricity price

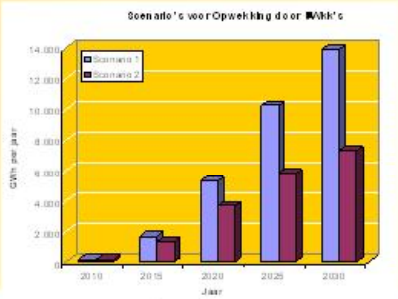


Ramp-up at 8:30

Flexibility is the KEY!

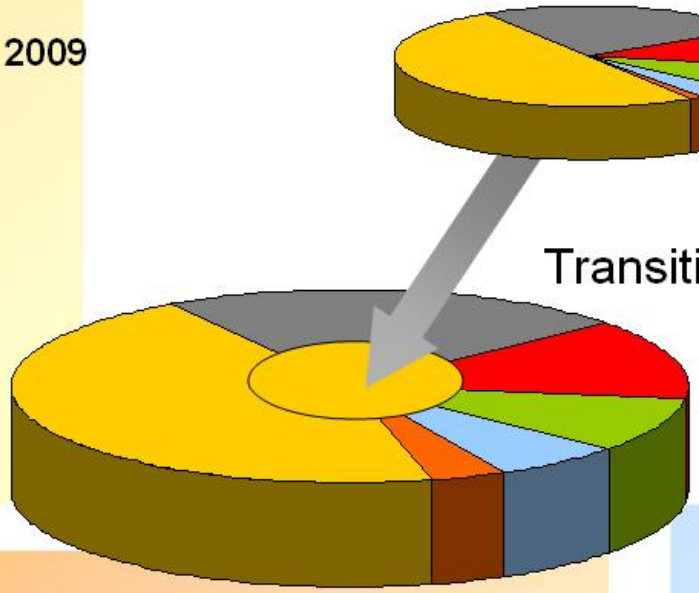
Gas- NL

micro CHP's
- start of roll-out expected in 2009



Today

Transition



Flexibility in Production by

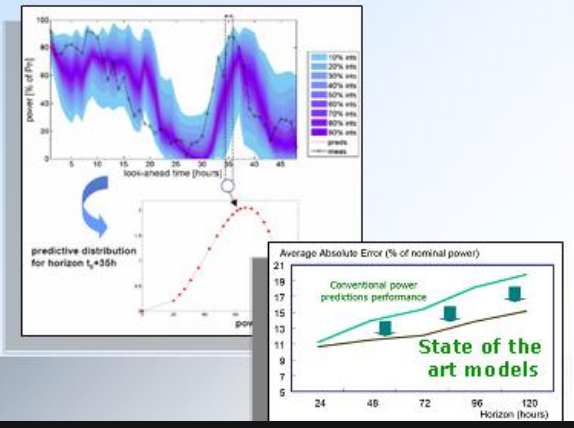
- Energy Storage
- Load Management
- Smart Comfort

Solar

Compensate "Unpredictable" Fluctuations

Wind

- Fluctuations 5 – 13% in predictions
- Large variations at short time scales



Netherlands system

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- Demand nearly 16000 MW
  - 1500 MW Import/Export
  - 700 MW from/to Norway day/night basis

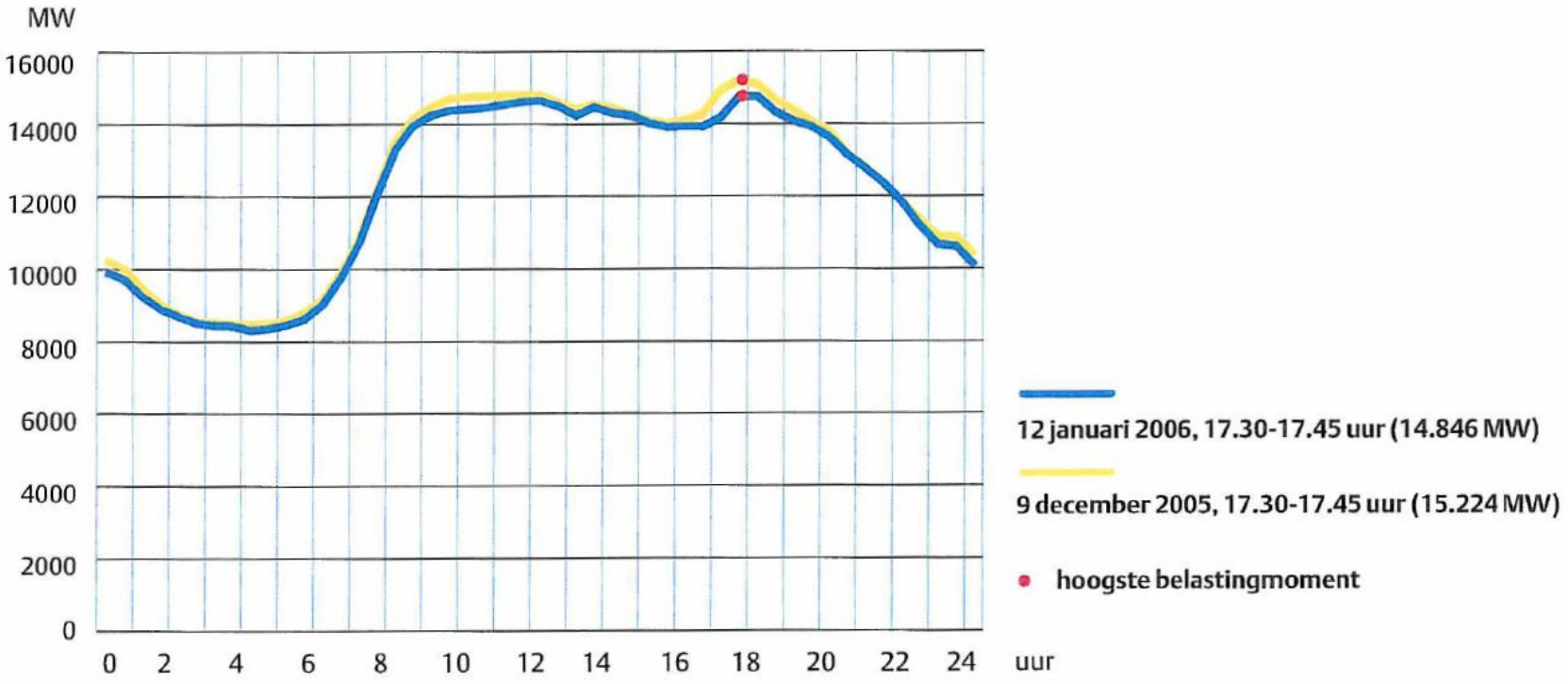
Drivers for DR:

- Security of delivery
- Recent near-blackouts
  - – Summer 2003: Cooling water shortage
  - – Winter 2004/2005: Over-abundancy of windenergy in Northern Germany
  - – 2007: switching error in Germany impact on UCTE system
- Embedding of renewables
- Trading benefits due to price volatility

But:

State-owned TSO (TenneT) has contracted part of DR-potential for contingency purposes

Day-night pattern total electricity demand in the Netherlands



- Daily load pattern has a relatively high day-night difference compared to other European countries
- Interest from E-sector for additional electricity demand during the night hours

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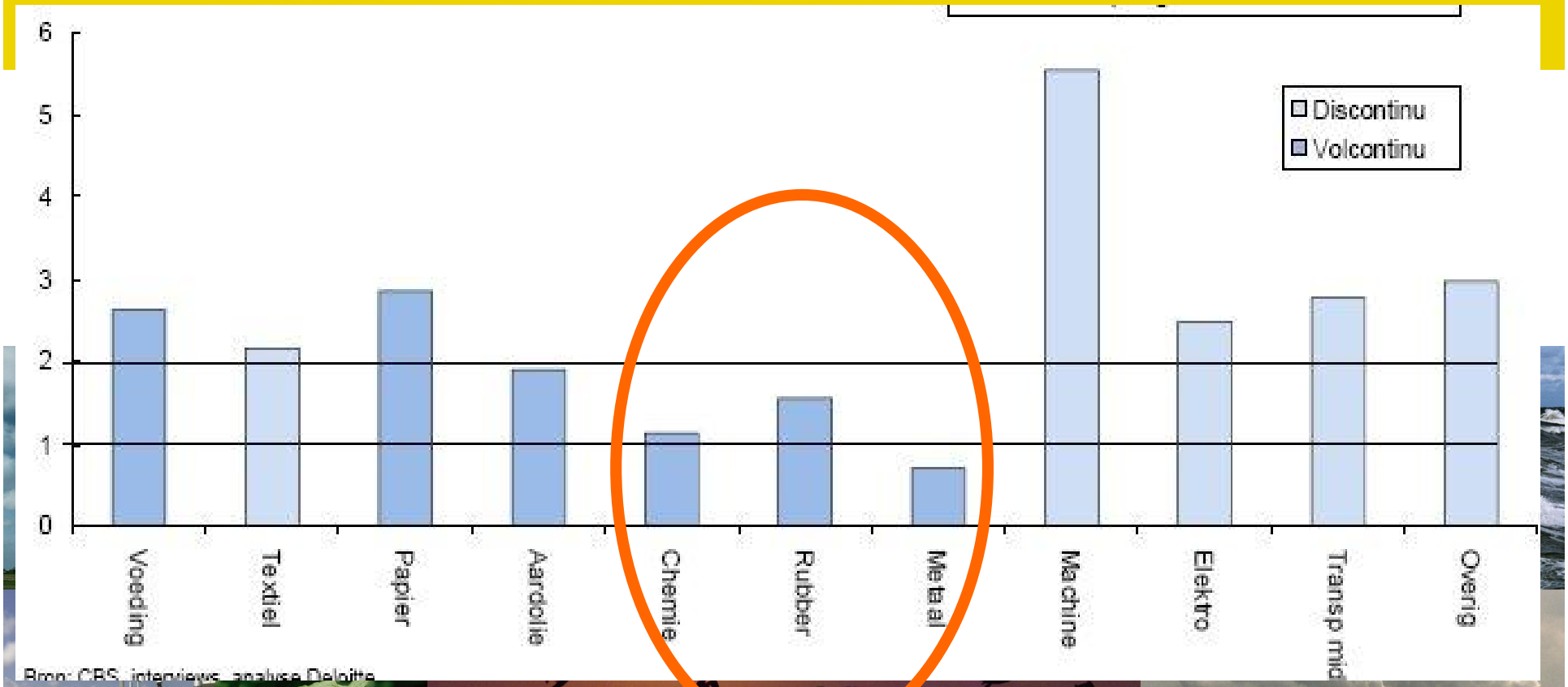
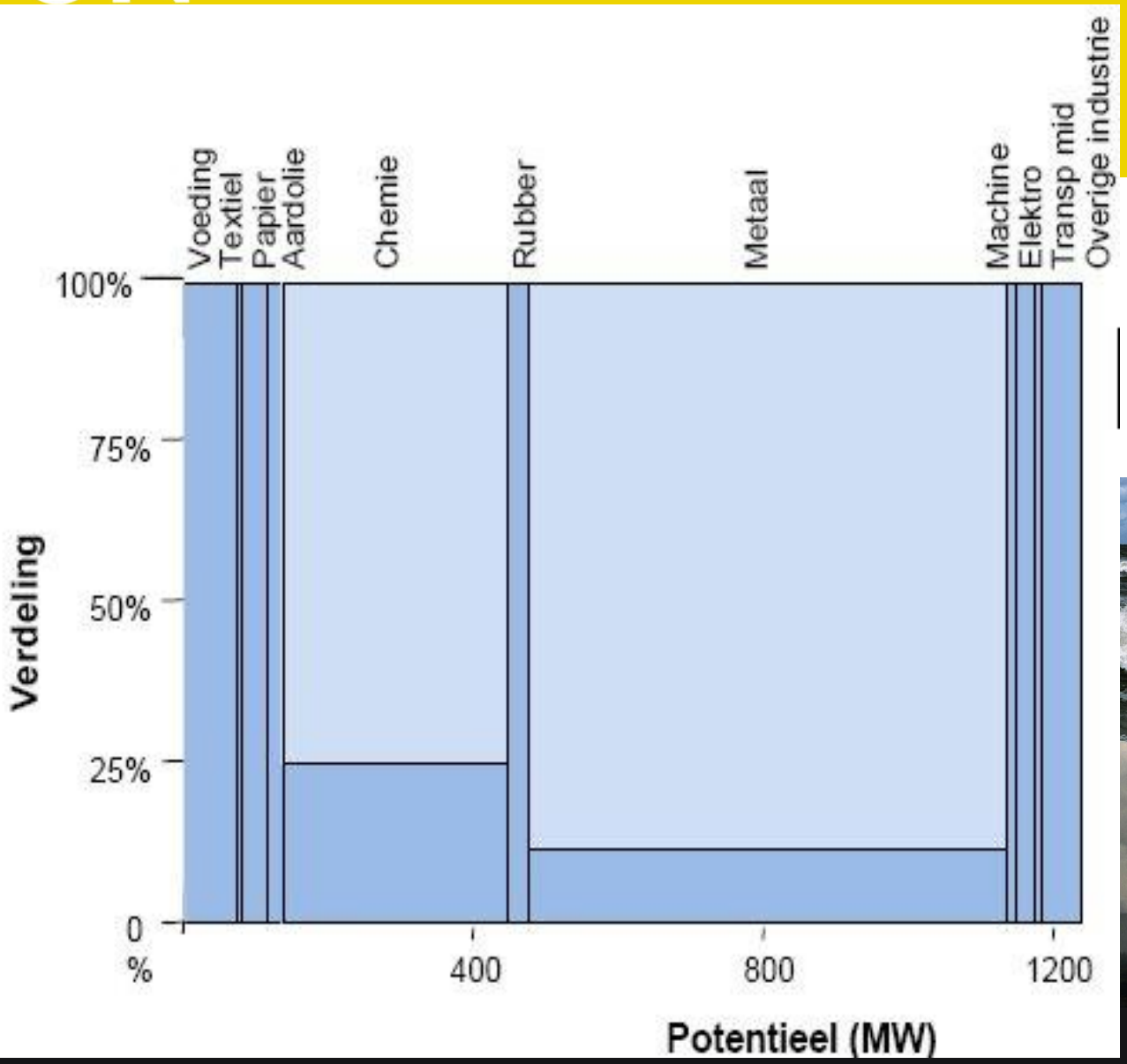
Cost of demand response per industrial sector LArge industry kEuro/MWh



Bron: CBS, interviews, analyse Deloitte

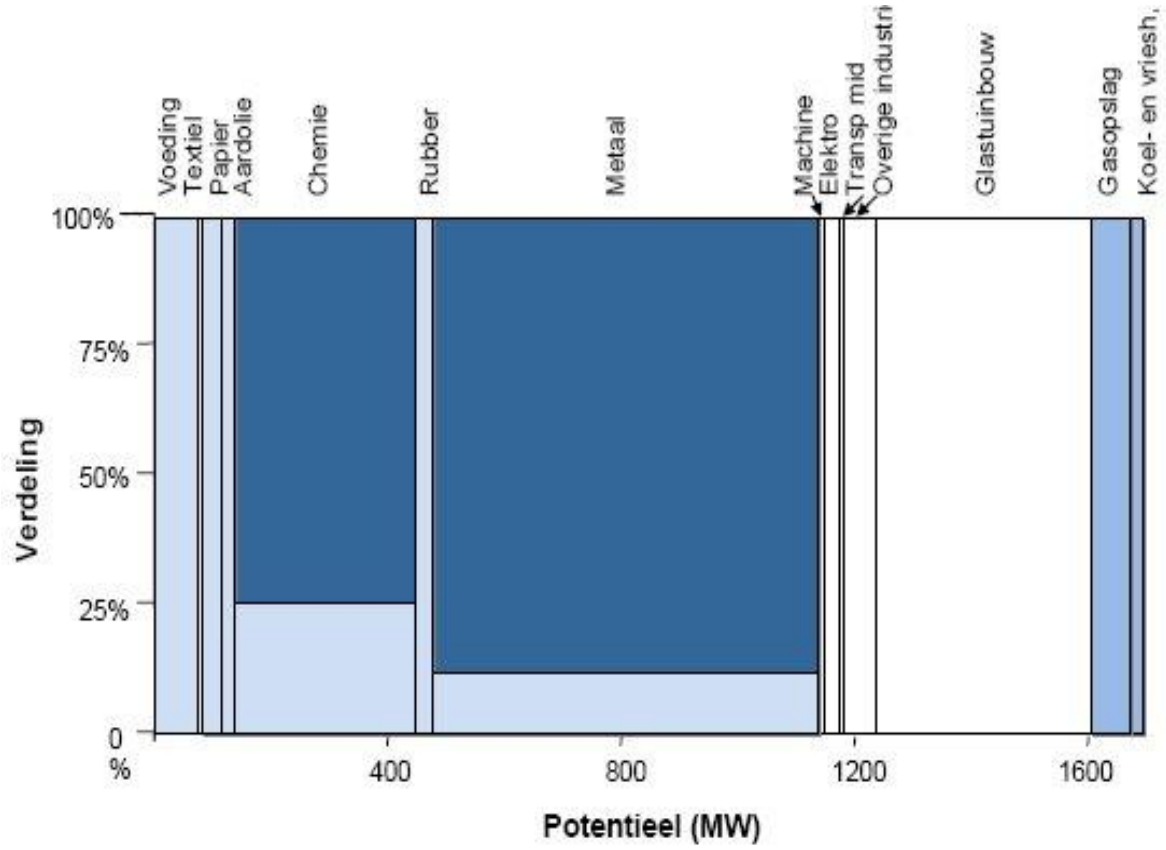
-> Metal, Rubber, Bulk Chemistry

Total switcheable load is 1200 MW
per large industrial sector: energetic (dark) and process (light) usage



Demand response in NL (1730 MW)

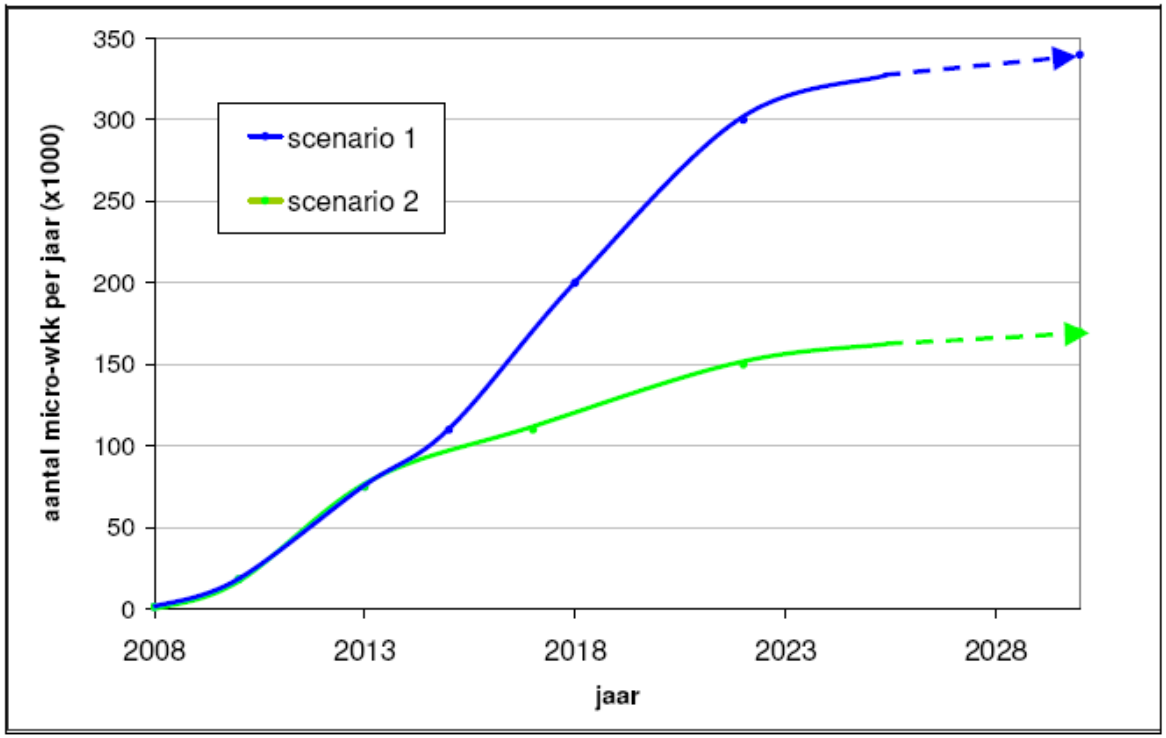
- **Non-industrial sector**
  - **Horticultural assilimilation lighting: 700 MW**
  - **460 MW via owned CHP; 275 MW islanded**
  - **425 MW available**
- **Total:**



Current main driver small customers: micro-CHP

Micro-CHP as a transition technology:

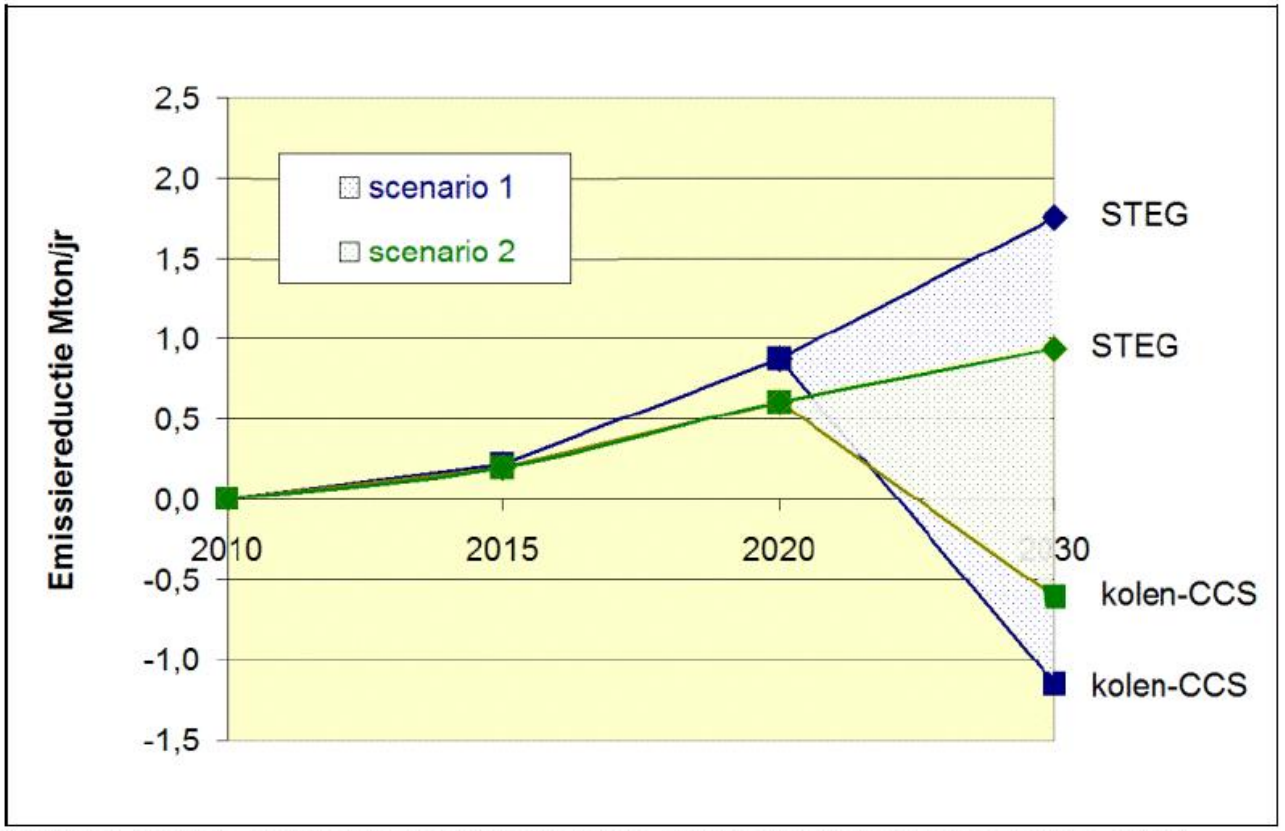
- Current rollout schedule (units/yr)
- Price 6000 Euro ->>> 2500 Euro in five years; i.e. 5 years payback time



Figuur 1.1: Twee marktscenario's voor micro-wkk in Nederland

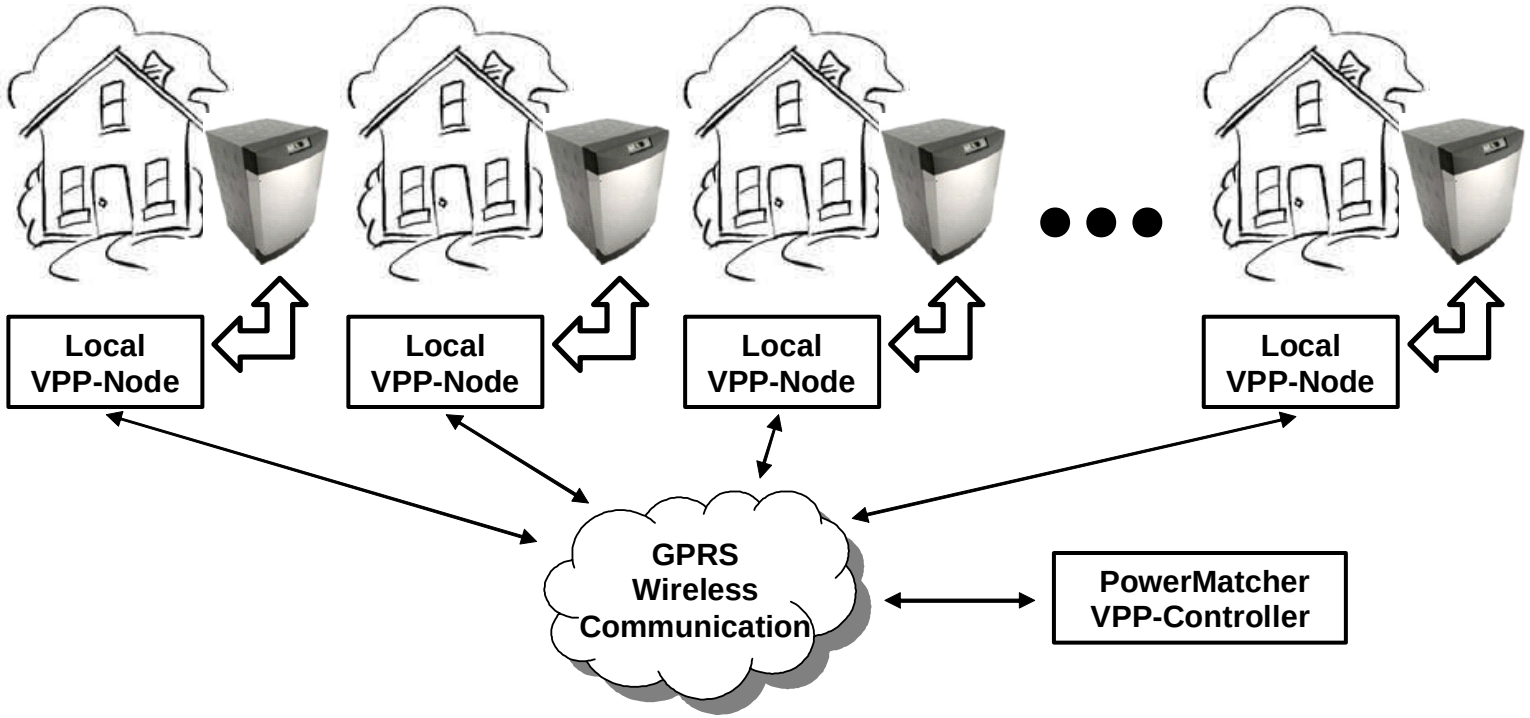
Current main driver: micro-CHP using Stirling

- Window of opportunity as a transition technology until 2020
- Carbon dioxide emission reduction

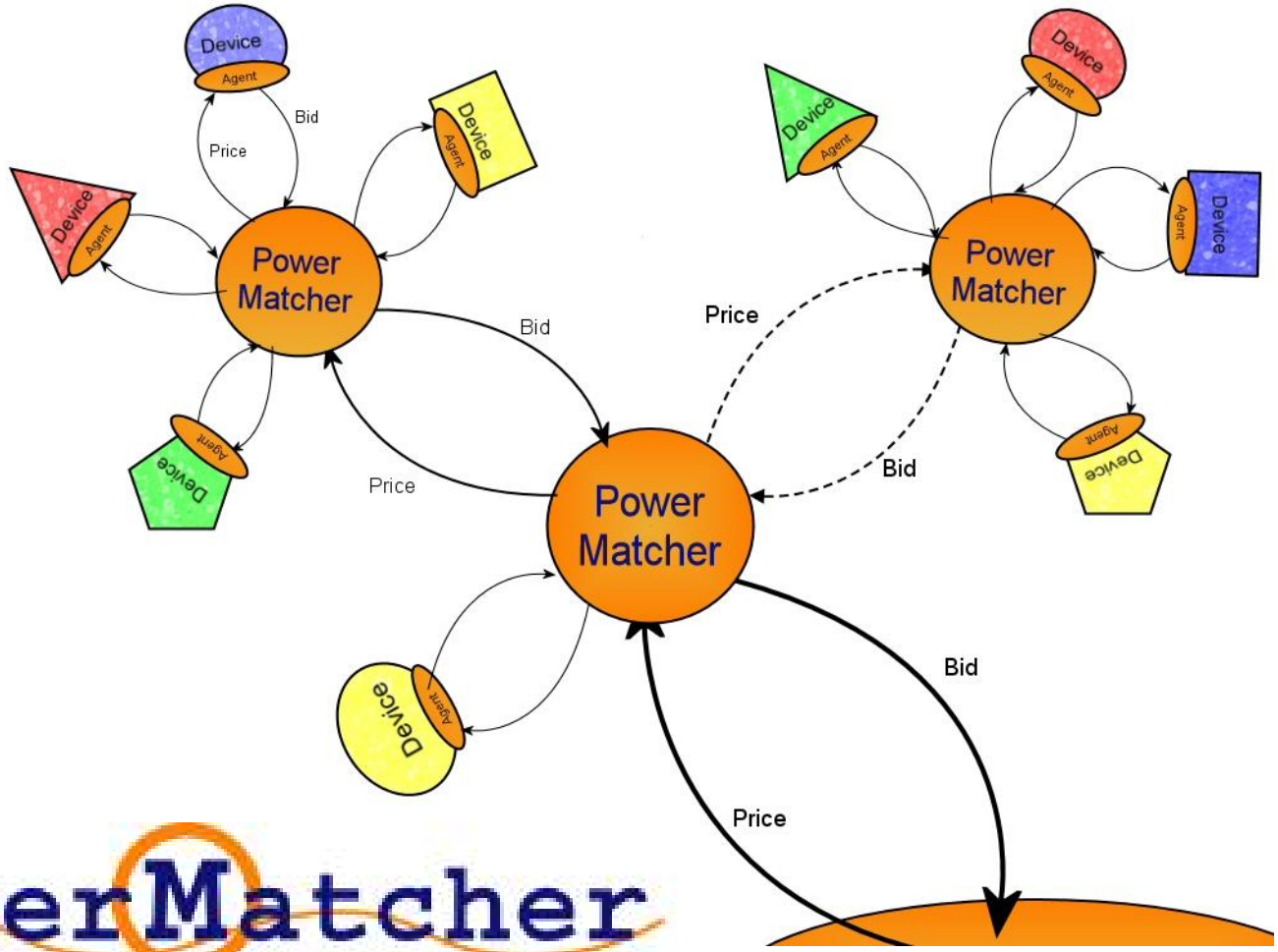


Figuur 1.3: CO_2-emissiereductie met micro-wkk in Nederland tot en met 2030

Clustered operation of micro-CHPs (HR-E) for grid-support
Load duration curve smoothening

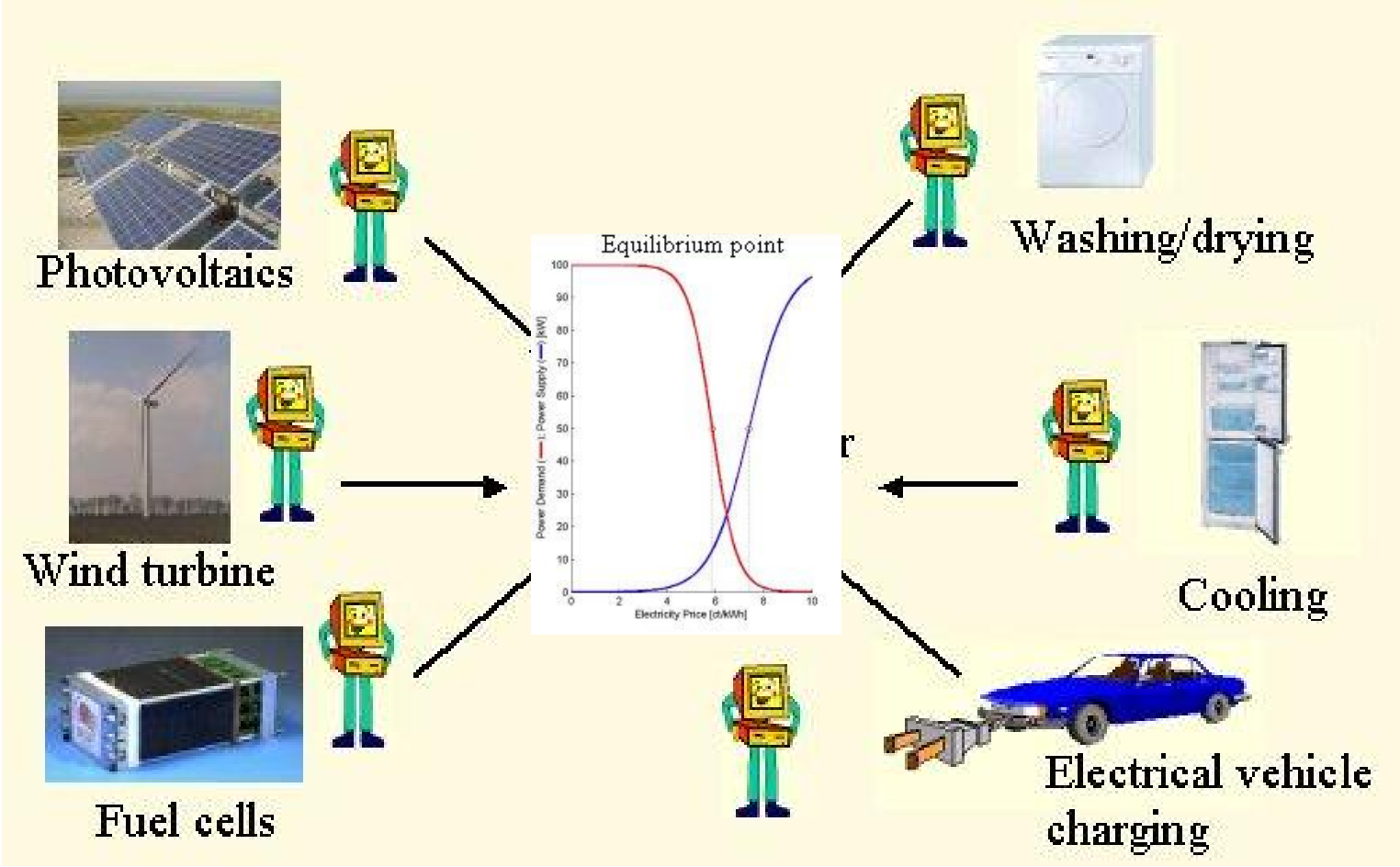


PowerMatcher agent ICT-structure

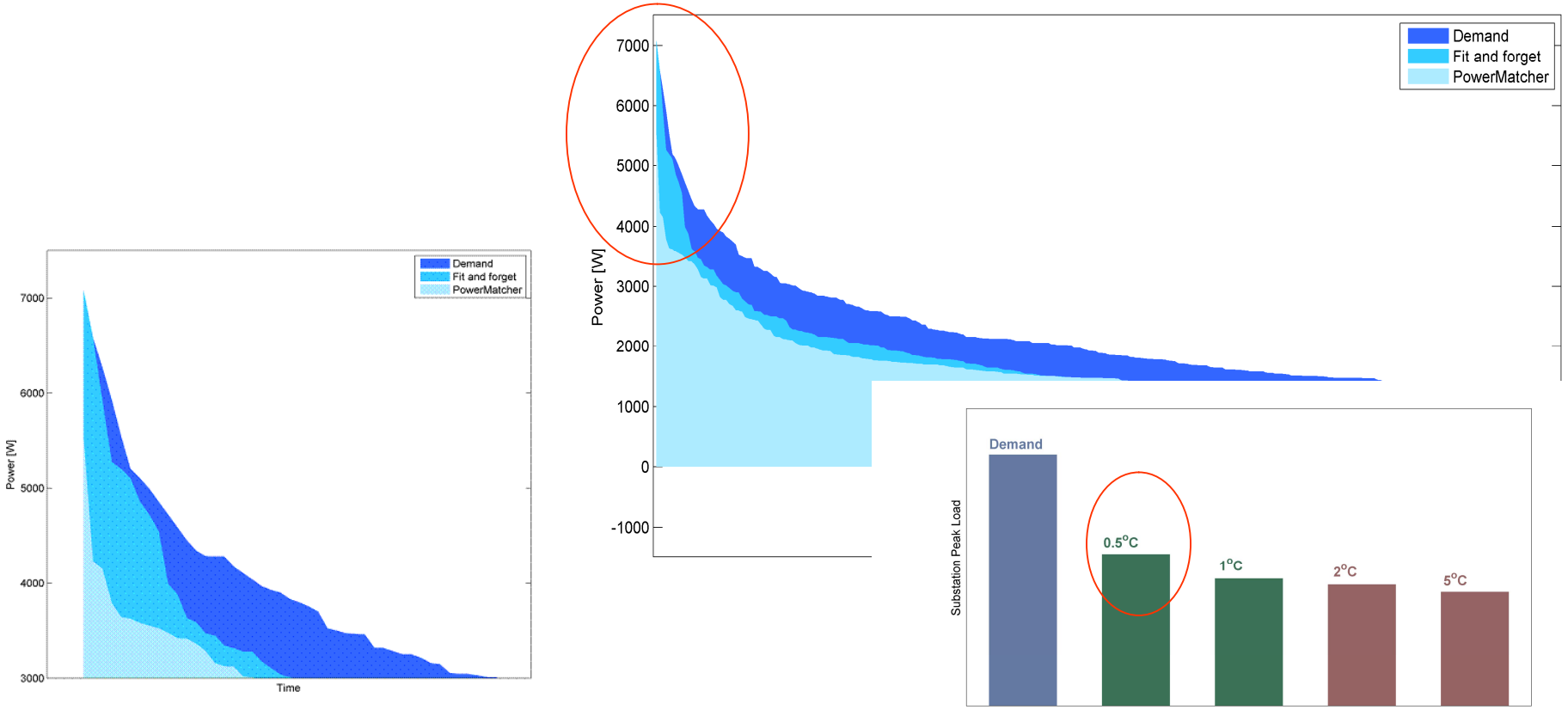


PowerMatcher

Coordination by PowerMatcher



ECN-Field test Results; load distribution



- In a summer situation (May 2007), the substation peak load is reduced by 30%. In winter, the reduction is 50%. Increase of thermostat bandwidth by 0.5 degr. suffices
- A conventional “fit-and-forget” control strategy does not reduce the substation peak load.

Demand response in NL: small customers

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- Future drivers
  - Energy efficiency/ feedback; intelligent metering
  - Tariff (prepaid, TOU); increasing prices
  - Automation, domotics, intelligent appliances
  - Local storage (heat, electricity) -> transport applications
  - User processes switcheable (washing, drying)
  - Increased load and load factor (variability); heatpumps and microCHP




Residential load shifting in the Netherlands in the future

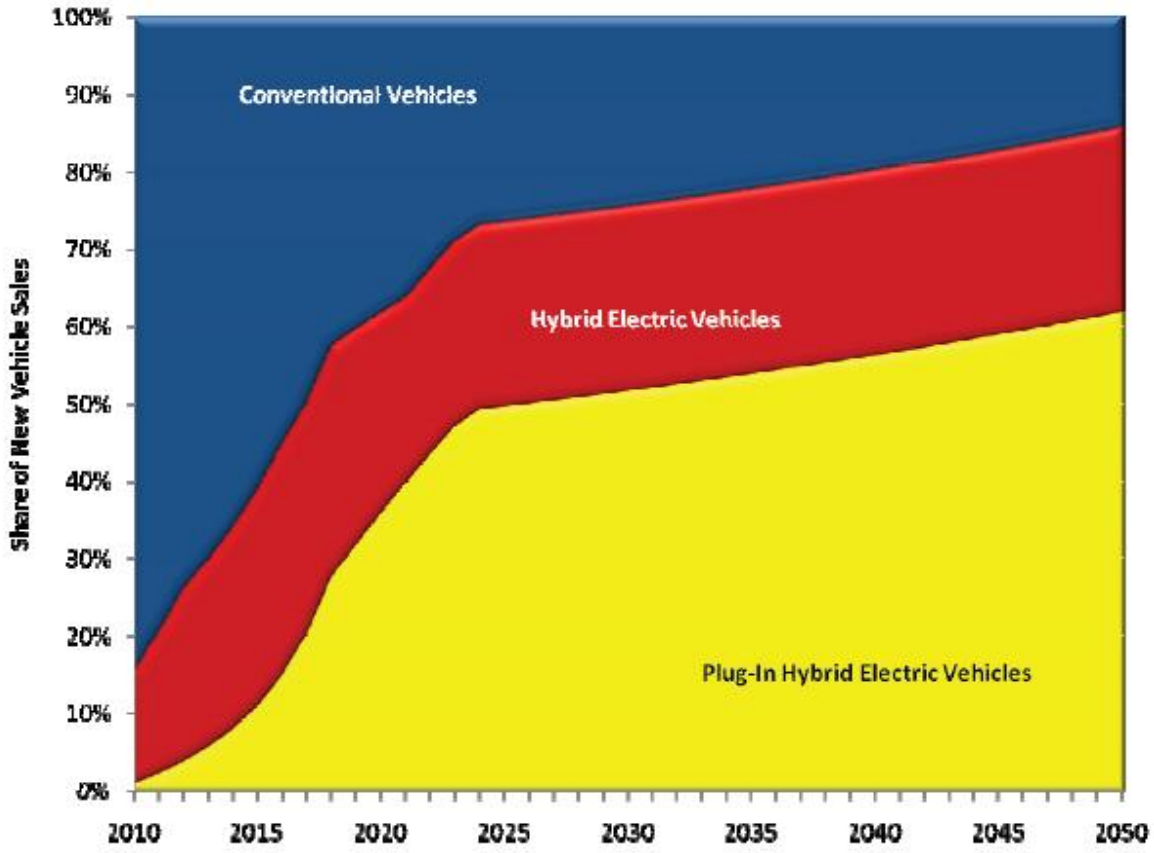
Electric appliances with a large future potential for load shifting:

- Plug-in hybrid electric vehicles
- Electric heat pumps
- Air conditioning

PHEV and hybrid vehicle introduction scenarios from EPRI

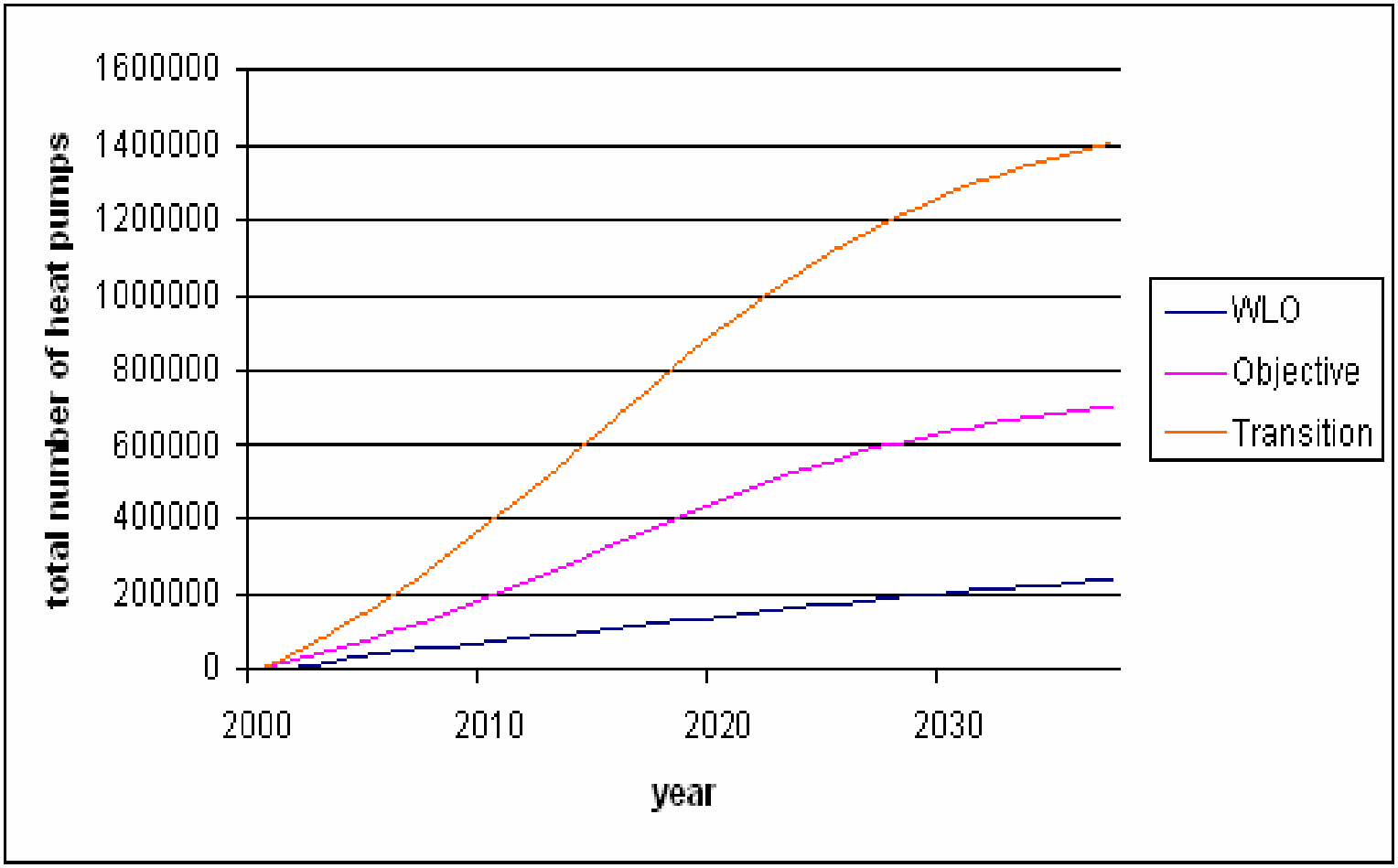
Peak new vehicle market share in 2050 for the three PHEV adoption scenarios

2050 New Vehicle Market Share by Scenario		Vehicle Type		
		Conventional	Hybrid	Plug-In Hybrid
PHEV Fleet Penetration Scenario	Low PHEV Fleet Penetration	56%	24%	20%
	Medium PHEV Fleet Penetration	14%	24%	62%
	High PHEV Fleet Penetration	5%	15%	80%



Assumed new car market share for the Medium PHEV scenario for conventional vehicles, hybrid electric vehicles, and plug-in hybrid electric vehicles for each vehicle category

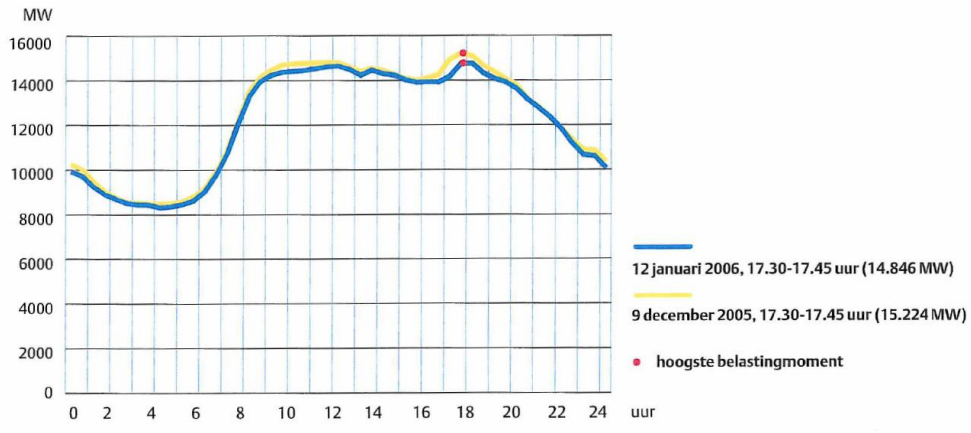
Heat pump introduction scenarios in the Netherlands



Contribution of PHEV and heat pumps to flatten day-night patterns

Table 9. Share of plug-in vehicle and heat pump electricity demand as percentage of final electricity demand in SE scenario, and their contribution to filling the 'night trough'

	2020	2040
Final electricity demand in SE scenario (TWh/a)	137	161
Electricity demand heat pumps + EV (TWh/a)	5.8	24.3
Heat pumps and EV as percentage of SE: (%)	4.2	15.1
Annual electricity demand to create a flat load curve (at load factor of 0.8) (TWh/a)	27	32
Heat pump and EV contribution to a flat load curve (%)	21	76



Conclusion: *if heat pumps and electric vehicles become popular, residential load shifting can almost completely flatten the total electricity load in the Netherlands*

CONCLUSIONS ITM PROJECT:

- 1.5 million heat pumps (2040) can provide the equivalent of 250 MW regulating power and 1.5 GWh storage
- 6.5 million PHEV can provide 26 GWh of storage
- Together this is sufficient to compensate most of the short term differences between predicted versus realised output of 10 GW wind farms

Residential load shifting (with plug-in hybrid electric vehicles and heat pumps) can contribute substantially to integration of intermittent renewables