Challenges and opportunities in the energy sector

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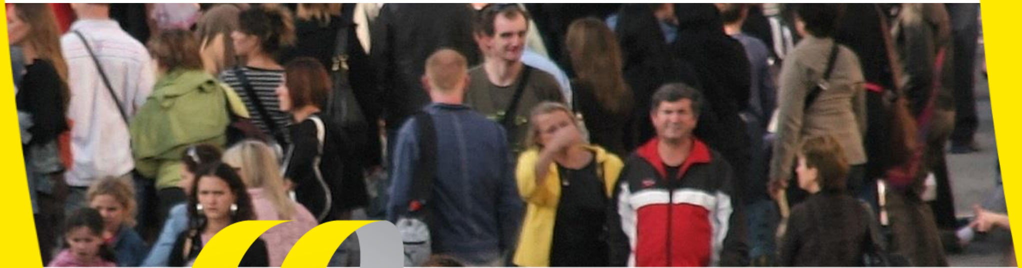

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Main drivers of the energy transition in Europe (1)

Main objectives of energy policies throughout Europe:

- Reliable supply
- Affordable, for households and industry
- Clean

Main drivers:

- CO_2-reduction targets: -80% to -95% in 2050, 40% in 2030, 20% in 2020;
- Renewable Energy Directive (RED) and ensuing Member States policies.

Additional drivers:

- Emission Trading System (ETS) – effects very limited so far
- National and regional economical support
- Cost reductions of renewable energy

Main drivers (2)

Renewable Energy Directive (RED):

- Binding targets for the share of renewable energy for all Member States
- A number of other provisions, for example on priority grid access, administrative procedures, monitoring and reporting, biofuel sustainability criteria.

A range of other EU policies affect energy developments

- State aid guidelines
- Third Energy Package
- Energy Efficiency Directive and EPBD
- R&D programmes.

State of play: What is happening in the EU?

Each Member State has a binding target for the share of RE in 2020

- EU overall target: 20%
- this includes electricity, heat and transport energy
- average share of renewable electricity in 2020: about 35%

Large differences between Member States:

- RE policy measures and public support
- RE shares and investments
- starting point (infrastructure, existing production capacity, energy resources, …)

- EU RE businesses: annual turnover €129bn, employ > a million people.
- EU imports 53% of its energy, at a cost of around €400bn per year.

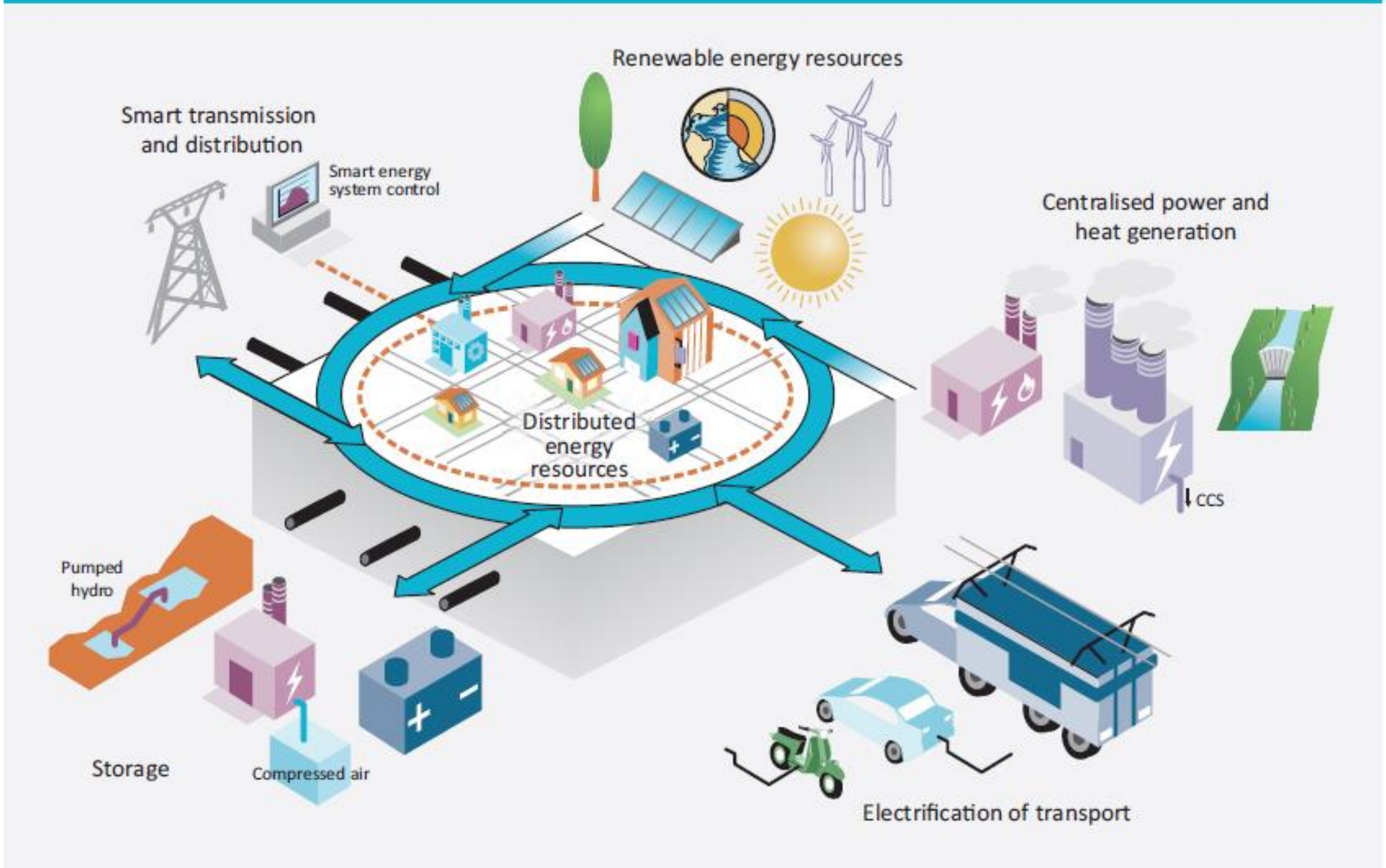
State of play (2)

Challenges for existing businesses

- Profits of coal and gas power plants reduce, due to a range of reasons:
  - overcapacity in various EU regions
  - high gas prices
  - increasing RE shares, with marginal cost of wind and solar power production almost zero
    - low prices when wind and solar production is high
- Grid capacity issues in some countries
- Significant investments needed, in production capacity, grids etc.
  - future system requirements uncertain
  - electricity market design and business models geared towards the old system

Scenarios for a future energy system

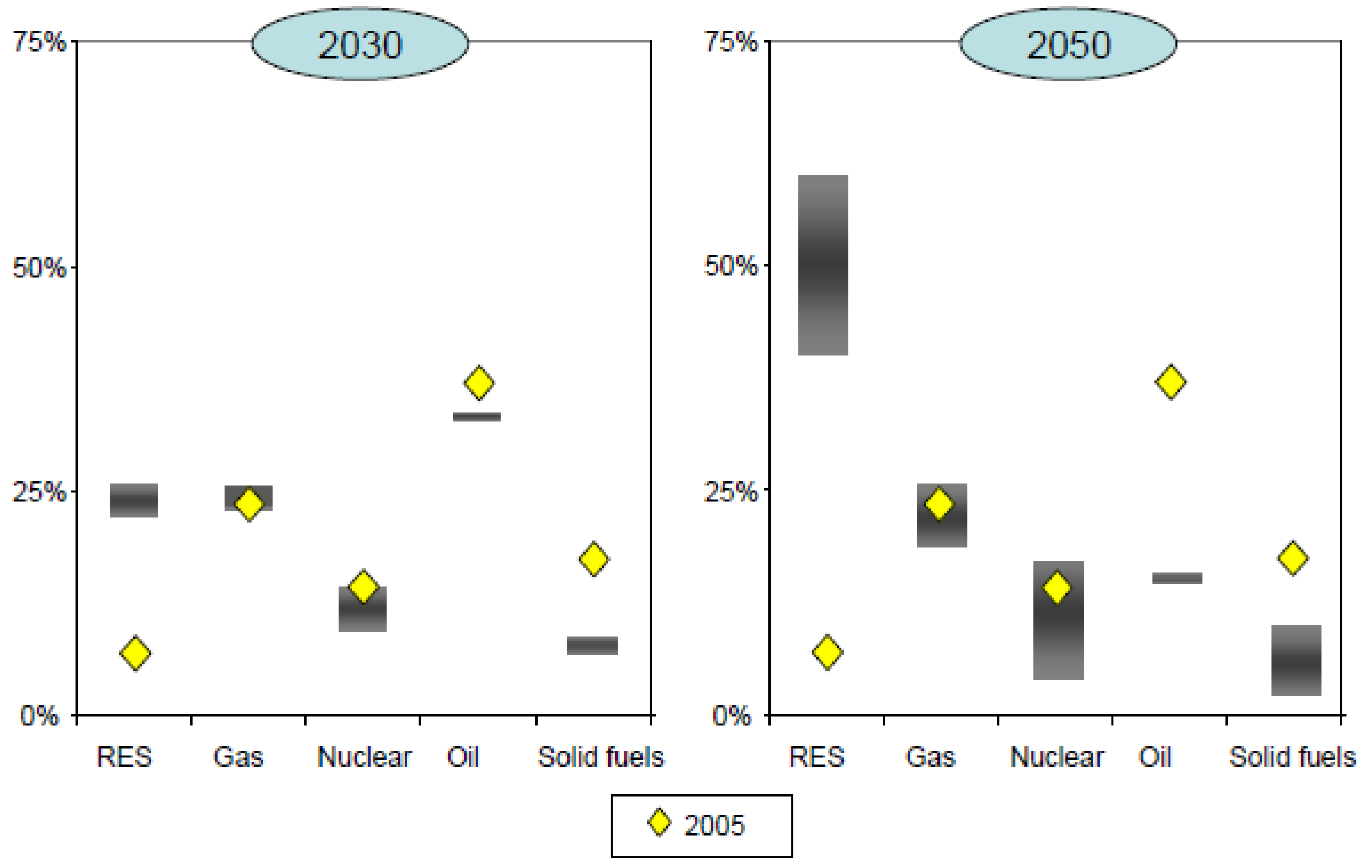
Figure I.2 The integrated and intelligent electricity system of the future



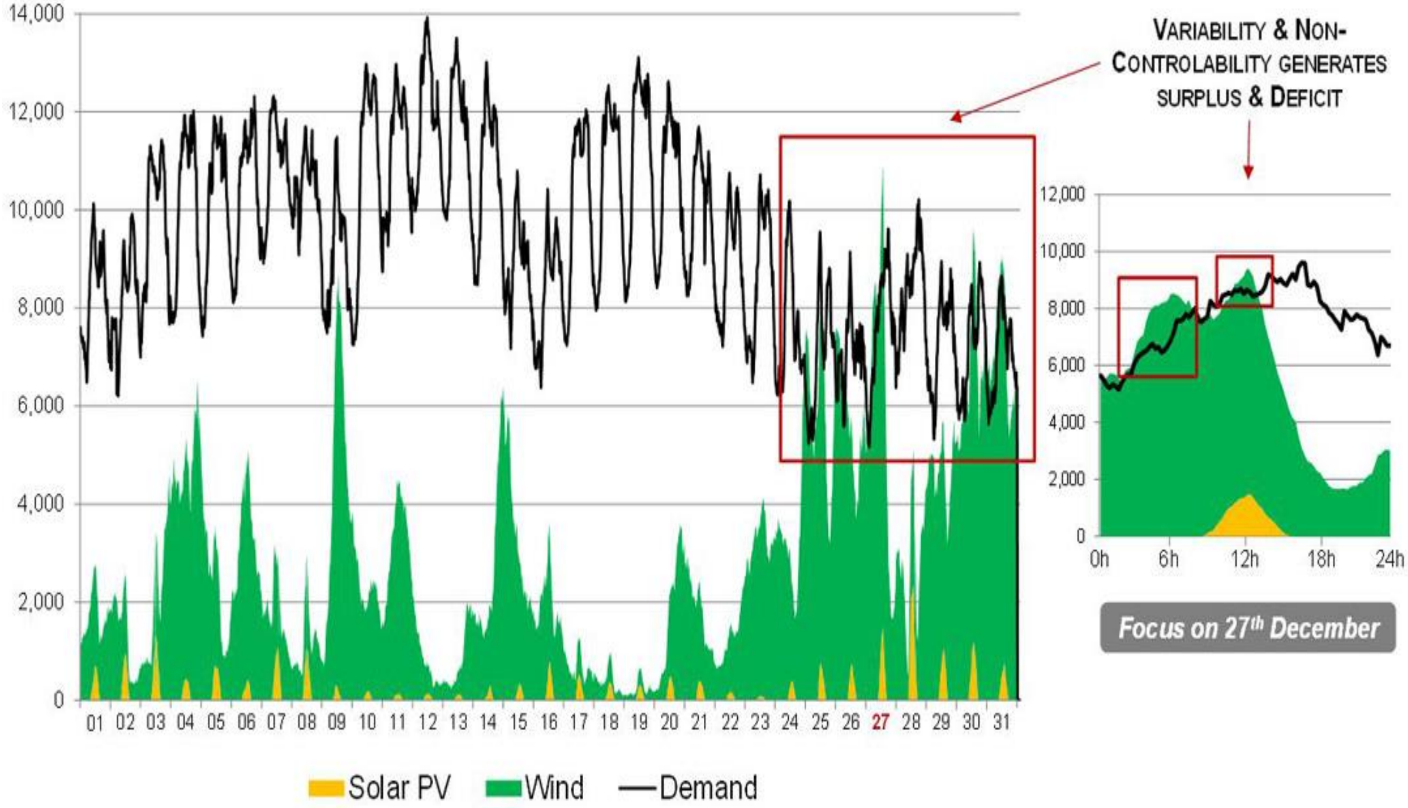
(IEA, ETP 2015)

EU Energy Roadmap 2050: 5 decarbonisation scenarios

Graph 1: EU Decarbonisation scenarios - 2030 and 2050 range of fuel shares in primary energy consumption compared with 2005 outcome (in %)



Profile for Germany, December 2013



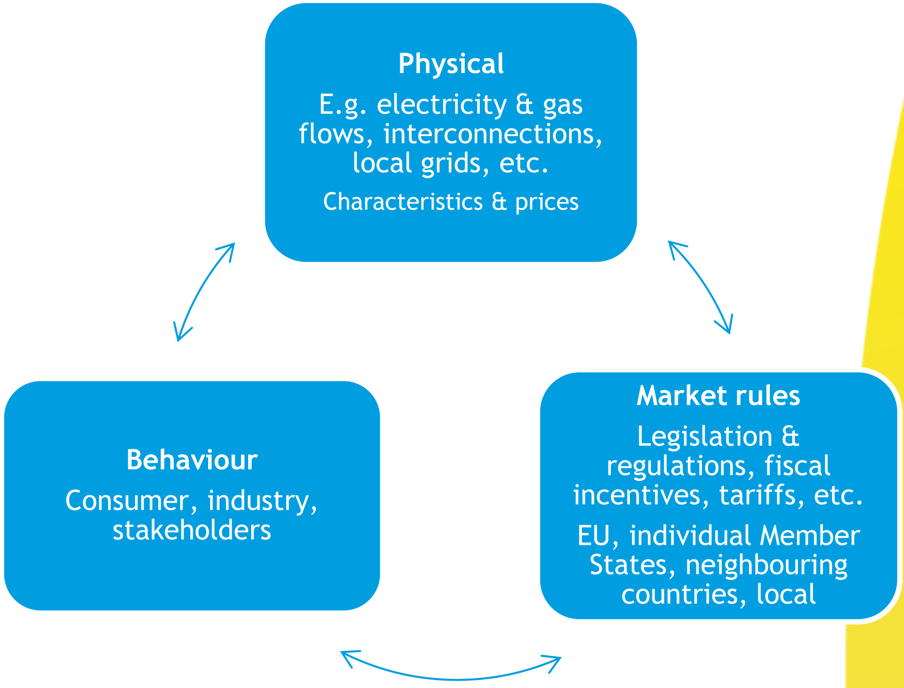
Changes in electricity system

- Fundamental change in dynamics due to growth of intermittent sources (onshore and offshore wind, solar PV).
  - In some countries, solar and wind output already exceed demand during certain periods. This is in store for the rest of the EU, too.
- Impacts profits and business models, infrastructure requirements, matching of demand to supply, etc.

Consequences:

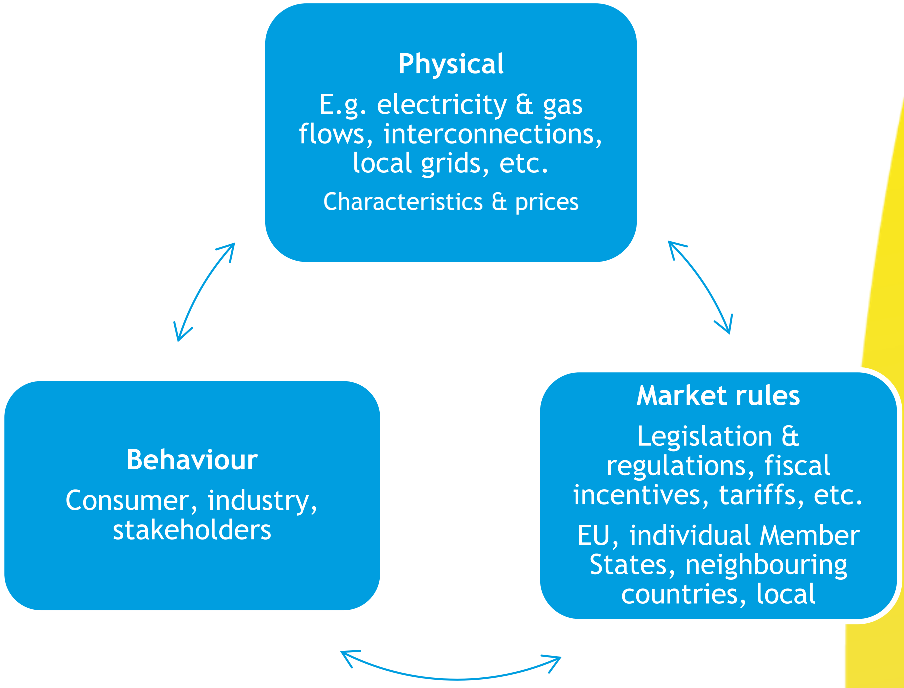
- Future affordable, reliable and clean energy requires changes to
  - Physical system
  - Consumer behaviour
  - Market rules

Physical trends



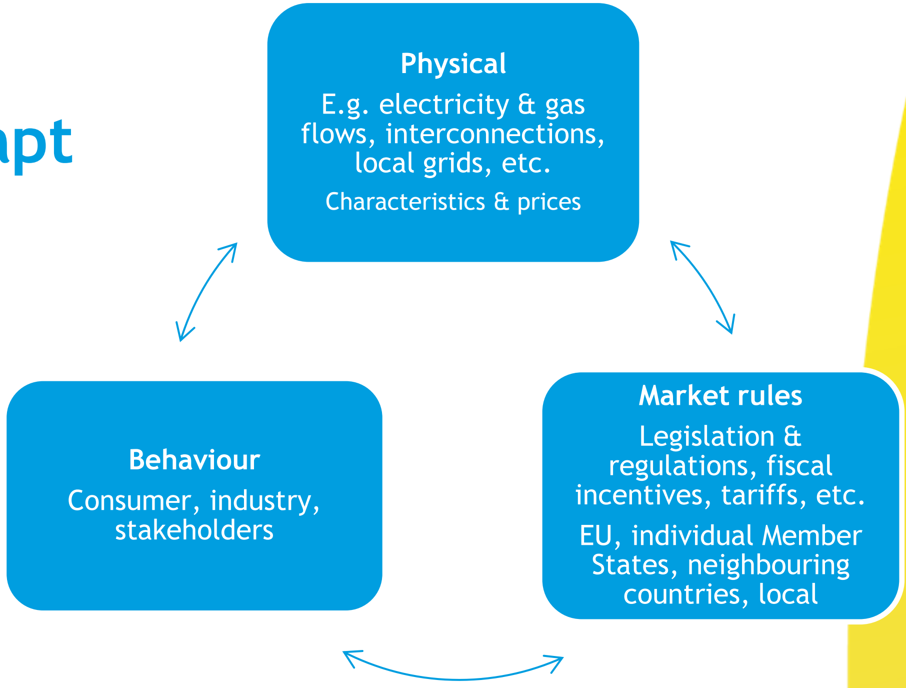
- Increased share of intermittent renewables
- Technological innovation, such as more efficient technologies
- Electrical/hydrogen vehicles, energy storage.
- More distributed power production.
- ICT developments.

Demand-side trends



- Citizens and industries are changing their energy related behaviour
  - making greater use of (new) technologies;
  - producers as well as consumers
- Barriers to meeting new needs and responding to new demands-side behaviour are often related to privacy concerns
  - technologically there is vast potential.

Market rules need to adapt



- Market rules need to change
  - to maintain affordability & reliability
  - to provide incentives for investments
- Changes also required on international scale
  - Increasing international market interconnection
  - Significant cost benefits to be achieved by international cooperation

Scenarios: many options and uncertainties

- CE Delft/DNG GL study for Netbeheer Nederland – the Association of Energy Network Operators in the Netherlands
- 5 scenarios for the Netherlands in 2030
  - Different ambitions lead to differences in energy efficiency, production mix and conversion efficiency.

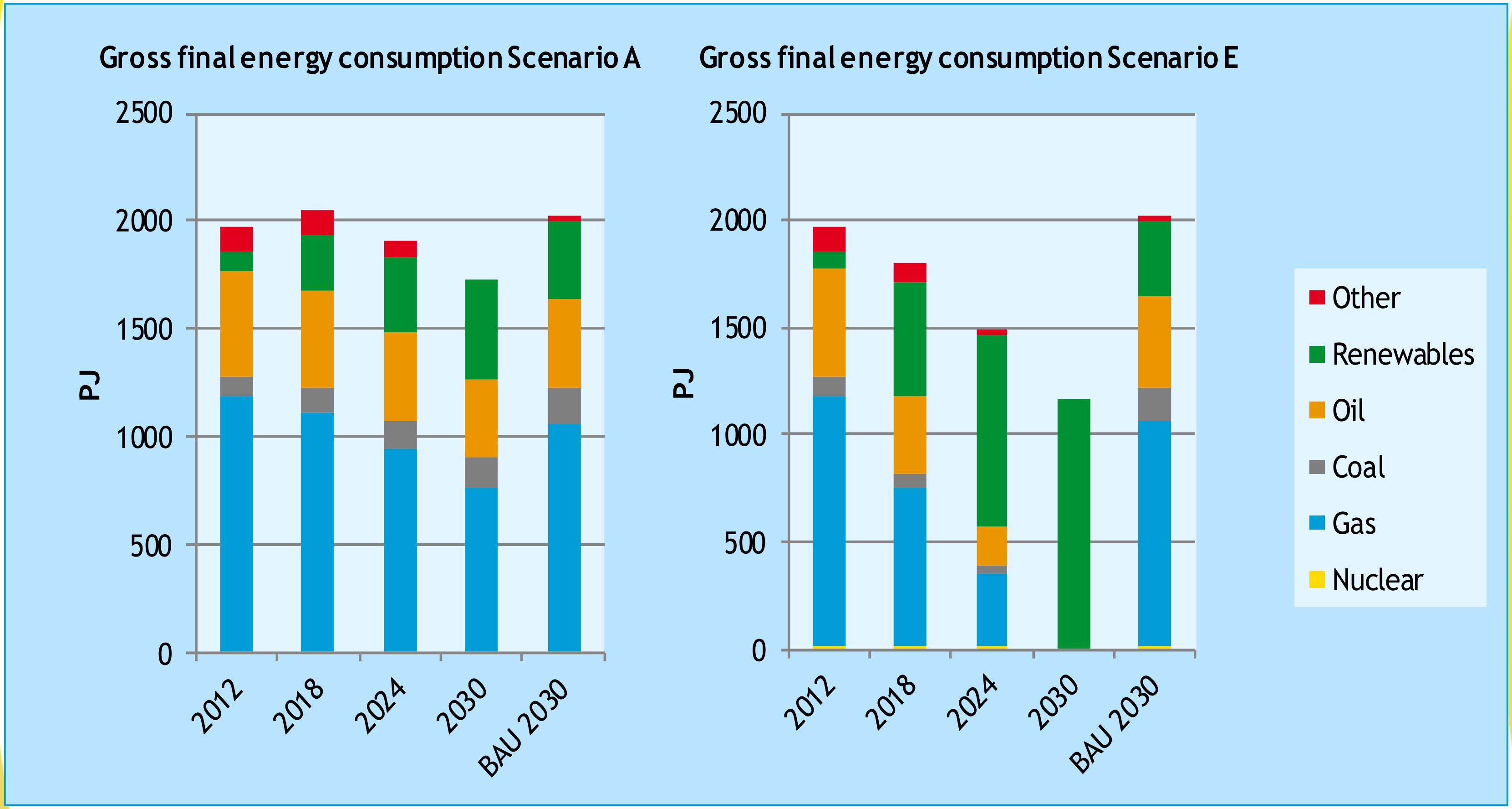
	A	B	C	D	E
CO_2 reduction	40%	40%	55%	100%	100%
Renewables	25%	25%	25%	25%	100%
Decentralized production	100%	<25%	100%	<25%	100%

- Assessment of feasibility, cost, grid consequences, etc.
  - electricity, transport, high and low temperature heat

5 scenarios for the Netherlands

Objectives	A	B	C	D	E
CO_2 reduction	40%	40%	55%	100%	100%
Renewables	25%	25%	25%	25%	100%
Decentralized Production (aim/achieved)	100% 37%	<25% 8%	100% 31%	<25% 8%	100% 67%
Key conclusions	Energy efficiency key. Significant investments in local grids needed	Carbon capture and storage (CCS) challenging. Fossil production can ensure match supply and demand	Energy efficiency key. CCS challenging. Fossil can ensure match supply and demand	CCS very challengin g. 20-50% EE in all sectors - unrealistic Fossil can match supply and demand	Huge challenge: solar and biomass volumes 20-50% EE in all sectors Local and seasonal storage Large share of EV
RE share	E: 38% T: 15% HT: 19% LT: 14%	E: 32% T: 15% HT: 14% LT: 17%	E: 35% T: 16% HT: 11% LT: 15%	E: 26% T: 20% HT: 15% LT: 26%	E: 100% T: 100% HT: 100% LT: 100%

Results for scenarios A and E



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Some common denominators in all scenarios

- Reduction of heat demand and substitution of natural gas by alternative forms of heating
  - need to re-think the role of today's gas infrastructure
- Electricity demand increases
- Demand needs to become flexible, and adapt to intermittent electricity production from wind and solar
- Growth of electricity from decentralised units (e.g. solar PV): major consequences for the low voltage grid.
- Large-scale decentralised energy storage needed

- Potential of interconnection and cooperation not specifically addressed in this study

Energy infrastructure: decentralized production

Energy infrastructure: Decentralisation of production

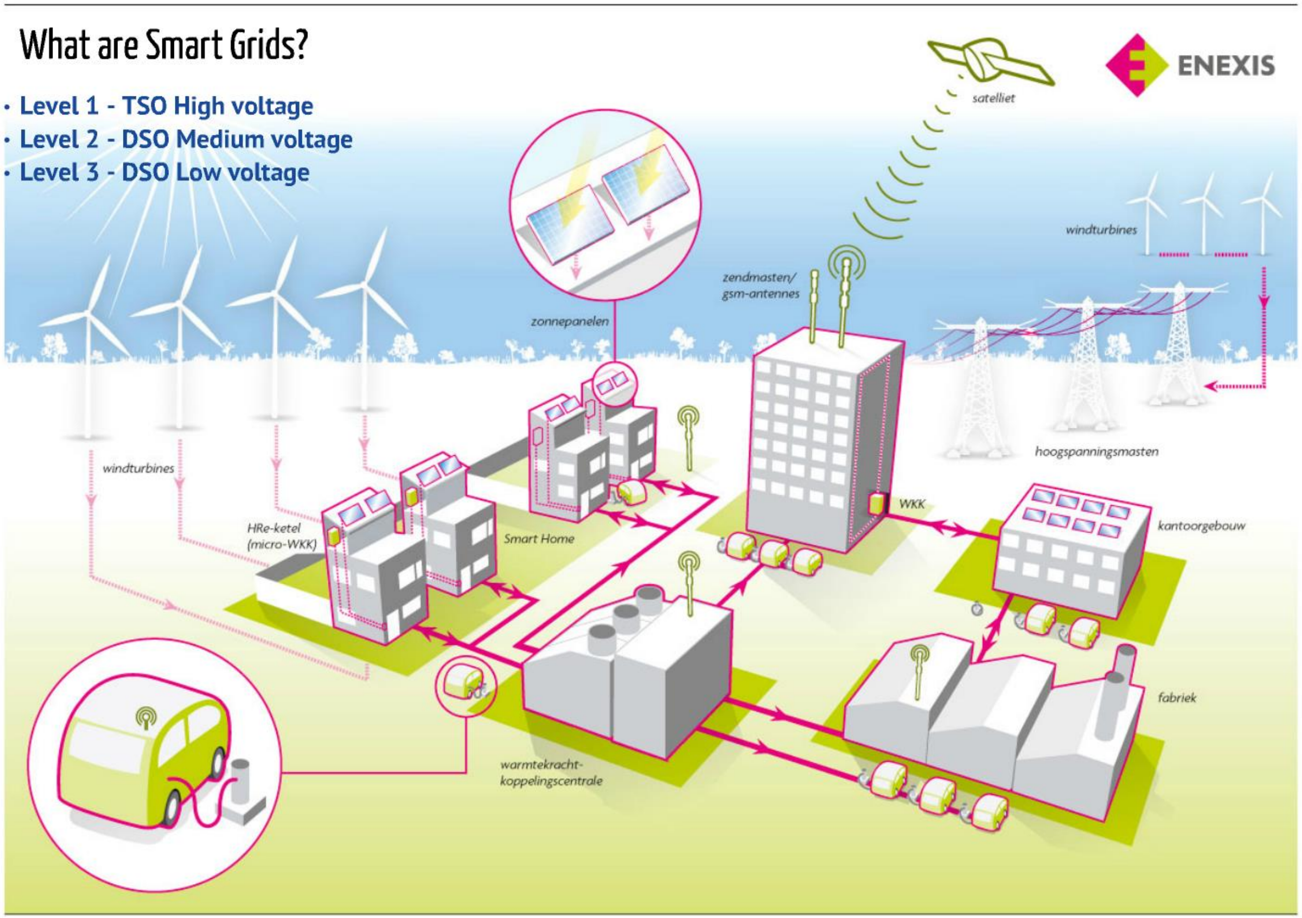
- Solar PV can lead to substantially heavier loads in LV grids
- Electrical heat pumps require more robust LV grids
- In addition: electric transport may require grid reinforcement.
- Grid costs may rise substantially, though extra capacity is used only limited hours per year.

- Local congestion (more output or demand than LV capacity and/or local demand) can be limited by local flexibility.
  - Shifting demand of households and SME: smart charging of EVs, smart heating with heat pumps, …
  - Energy storage: batteries, heat, etc.
  - Improved grid management

Decentralised production requires flex-options

- Need for flexible options for continued match between demand and output (system reliability and affordability)
- Flexible options for solar/wind surplus:
  - extra demand (substitution, demand-shifting, to storage);
  - output reduction (ramping down of wind, curtailment of solar).
- Flexible options for deficits:
  - extra output (e.g. gas turbines, from storage);
  - demand reduction (consumer (automatic) disconnect).
- Short term (hours, days) & long term (season).
- Both central and distributed.
- Fluctuating weather regime requires rapid-response flex-options.
- Greater interconnection can increase security of delivery.

Energy infrastructure: Smart Grids



Energy infrastructure: What are smart grids?

- Ensuring that grid connections and grid components meet demand for power transmission and distribution in a smarter, more secure manner
  - improved grid management
  - roll-out of new Smart Grid-based services to homes, offices, business premises

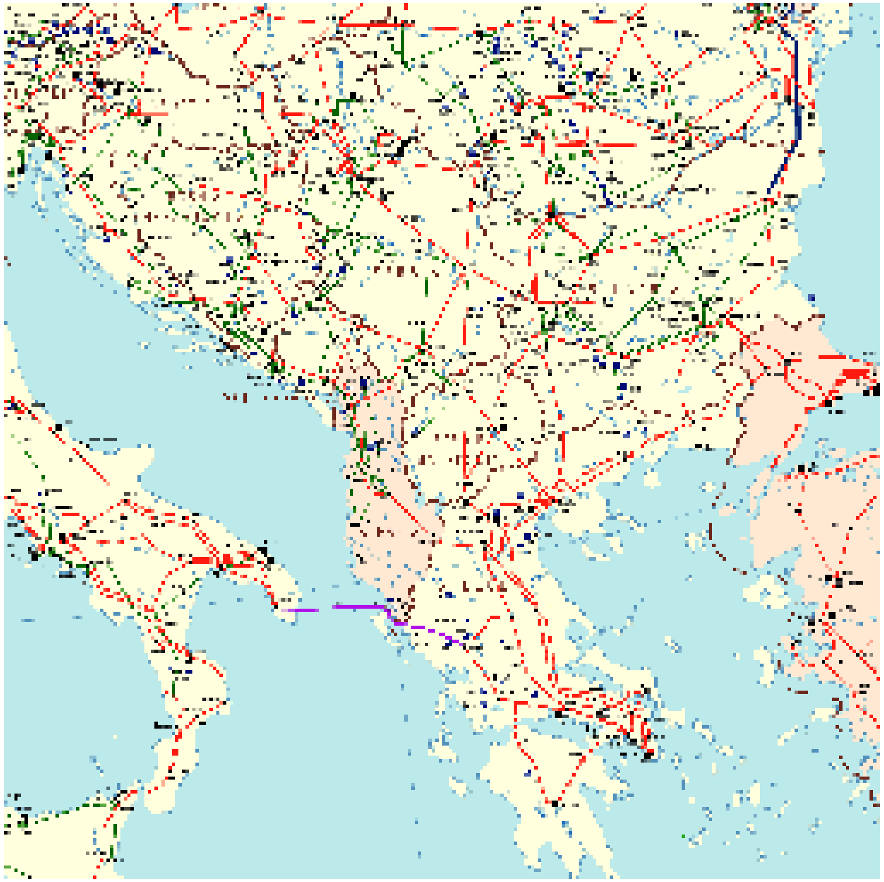
- Many different measures
  - intelligent grid management by grid operators
  - intelligent management of electricity demand, including local energy storage systems, household appliances, electric vehicle charging, curtailment of power supply, etc.
  - consumers provide flexibility services to a range of 'procurers', including TSOs, DSOs, suppliers, directly or via aggregators

Energy infrastructure: smart grids

Smart grids can be beneficial both for a future with renewables and a future with fossil plants

- Main benefits (for the Netherlands, CE Delft study):
  - Less grid expansion needed (peak shaving of demand and supply)
  - Less need for centralized power plants
  - More efficient use of centralized power plants
  - Can help grid balancing
- Main barriers:
  - Investments: connections and its components must be ‘smart’
  - Privacy concerns
  - Currently no incentives for consumers to participate
    - price incentives seem an essential precondition

Energy infrastructure: Interconnection & harmonisation



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Energy infrastructure: Interconnection

The EU aims to develop an Internal Energy Market

- with an efficient sharing of resources across borders
- physical interconnection and optimising system operations
- benefits due to optimal siting of renewable generation assets
- reduces capital investments (capex) and operating costs (opex)

Energy infrastructure: EU-wide harmonisation

- The current situation:
  - very diverse, national policies
  - very limited cross-border cooperation
  - lack of trust, perception of uncertainty, security of supply concerns
  - inadequate interconnection

- A range of initatives at EU level
  - Integrated Energy Market main objective in EU energy policy
  - Targets for increased interconnection
  - Energy Union: key to the new European Commission
  - Plans to include a more regional approach in 2030 energy policy framework

Implications for jobs and employment in the sector (1)

- A renewable energy system is likely to create more jobs than the current system
  - reduces energy imports
  - significant investments in solar power and on- and off-shore wind (plus operation and maintenance)
  - grid expansion on all levels
  - development of new technologies
    - flexible demand and energy storage, smart grids
  - intelligent (and complex) grid and demand management, on all levels

- The transition will impact different companies in different ways

Implications for jobs and employment (2)

- A renewable energy future requires different skills than a fossil future
  - Less centralised, fossil power plants
  - Production of wind turbines, solar panels and CSP
  - Energy storage
  - Installation and maintenance
  - ICT skills needed to develop and operate the smart grids
  - More interaction with consumers/prosumers
  - More service providers
  - A much more international energy market with increased interconnection and system optimisation on regional scale

Conclusions

- Ambitious EU and Member State climate goals expected to lead to significant changes to the electricity sector
- Changes to electricity production will impact on infrastructure requirements
  - Grid expansion on LV and MV levels, smart grids, interconnection
- Developments still uncertain, different scenarios possible
- Cross-border cooperation and interconnection may lead to signficiant cost savings
- National policies and focus significant barrier to an integrated energy market
- Impacts on employment may be signficant
  - Overall expected to be positive, but different skills required

Questions for group discussions

- What impacts from the increased shares of renewable electricity have you seen in your company/trade union?
- How could a growing share of decentralised electricity production (solar, wind) affect your company/trade union?