Options for additional flexibility from sector coupling – electrification of heating and transport sectors

Energy system integration requires changes to market design

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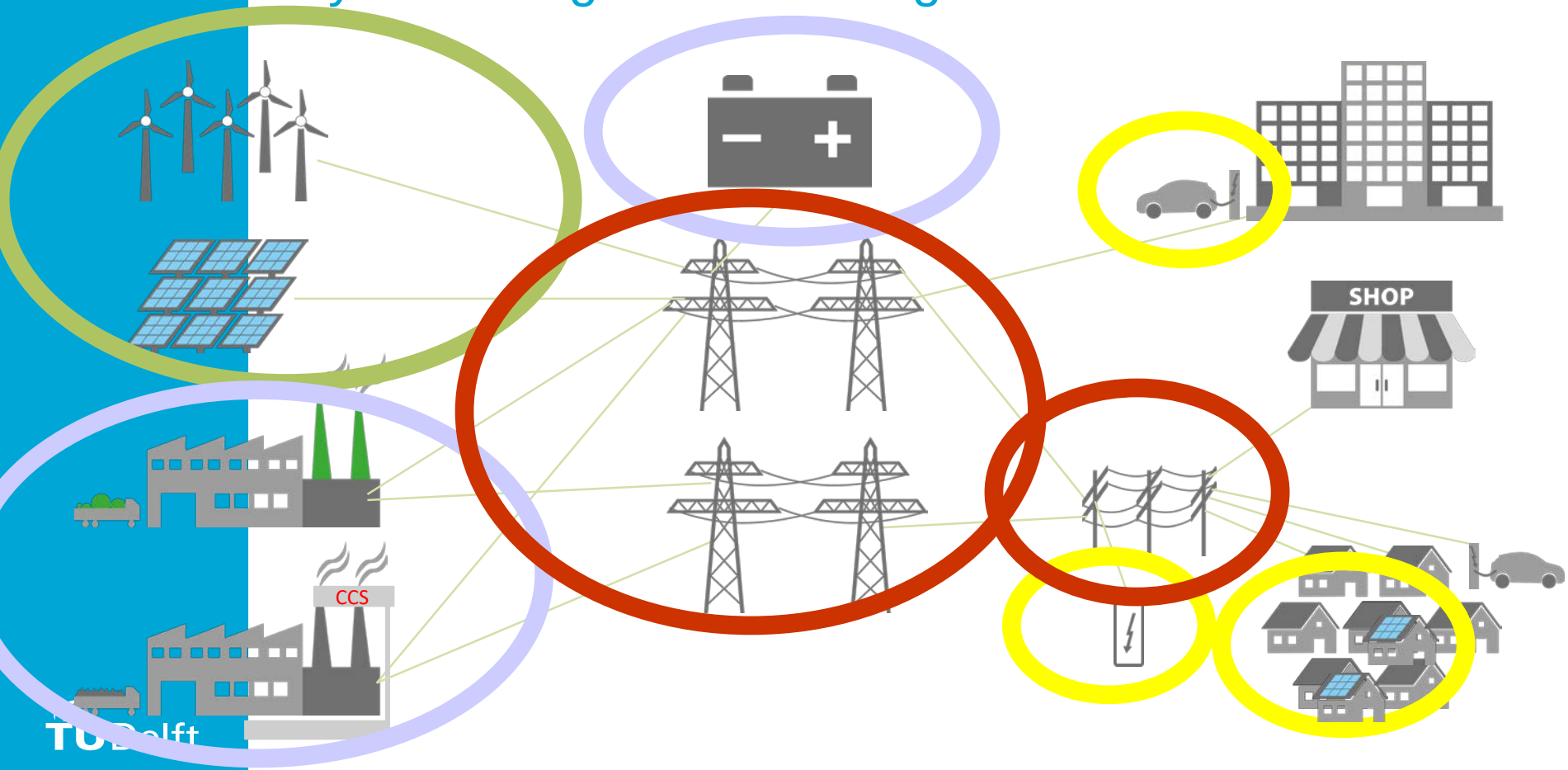
System integration challenges



Two examples

- Integration of electric vehicles (EVs)
- Development of non-fossil home heating options

Electric vehicle charging

- Should respond to wholesale prices;
  - To optimally make use of its flexibility
- Should avoid distribution grid overload.

Techical challenges:

- Grid overload is not likely to happen often until there are large numbers of EVs, but must be avoided
  - The control signal does not need to occur often, but needs to be effective
  - This requires planning over multiple time steps
- The DSO needs to communicate the grid constraint with the vehicle owners.

Options for avoiding grid overload from EV charging:

- Direct control by the DSO:
  - Against free market / self determination
  - Acceptability for consumers?
- Control by aggregators:
  - How to allocate grid capacity among aggregators?
    - Let aggregators bid for network capacity?
  - Consumers will need to indicate their preferences – privacy issues?
- Price signals:
  - How to shift load optimally over time?
    - Only real-time prices work; all proxies (such as Time of Use prices) are ineffective.
  - Too complex for consumers? Can smart algorithms do the job?

Heating homes

- Options for replacing natural gas and oil:
- Electric heat pumps
  - (electric resistance is not attractive)
- District heating
  - Using geothermal heat, heat pumps, other renewable heat sources?
- Hydrogen gas
  - Using existing gas network
    - Technically feasible?
    - Would require replacement of all gas-burning equipment
  - Source of hydrogen: ‘surpluses’ of solar and wind energy
    - Large conversion losses

Home heating: system integration challenges and opportunities

- Opportunity: heat can be stored, home temperatures may fluctuate a little → cheap source of flexibility.

- Challenge: in which energy carrier to invest?
  - Heat pumps: their efficiency drops when ΔT increases → demand spikes
  - H_2: technology ready? What about the low energy density? High energy losses in production
  - Heat networks: availability of primary energy sources? High network costs, rigid infrastructure.

Home heating: further system challenges

- All options depend on electricity, but in different degrees.
  - The impact on future electricity demand can be large.
  - How to decide about electricity network capacity investment?
- The degree of insulation affects the choice of energy carrier
- Integration with cooling and energy storage?
  - More efficient, but only possible for multiple home systems → increasing complexity

Analysis

- EVs potentially cause high demand peaks
  - Shifting these peaks is cheap, but market design for load shifting is complex.

- A similar market design challenge may develop for home heating
- But here the larger challenge is how to decide between energy carriers.
  - Different actors decide about the different carriers:
    - Electrification is a private decision
    - H_2 requires the gas grid to be converted
    - District heating requires local government initiative.