Financing Hydrogen Projects
Business cases and political support

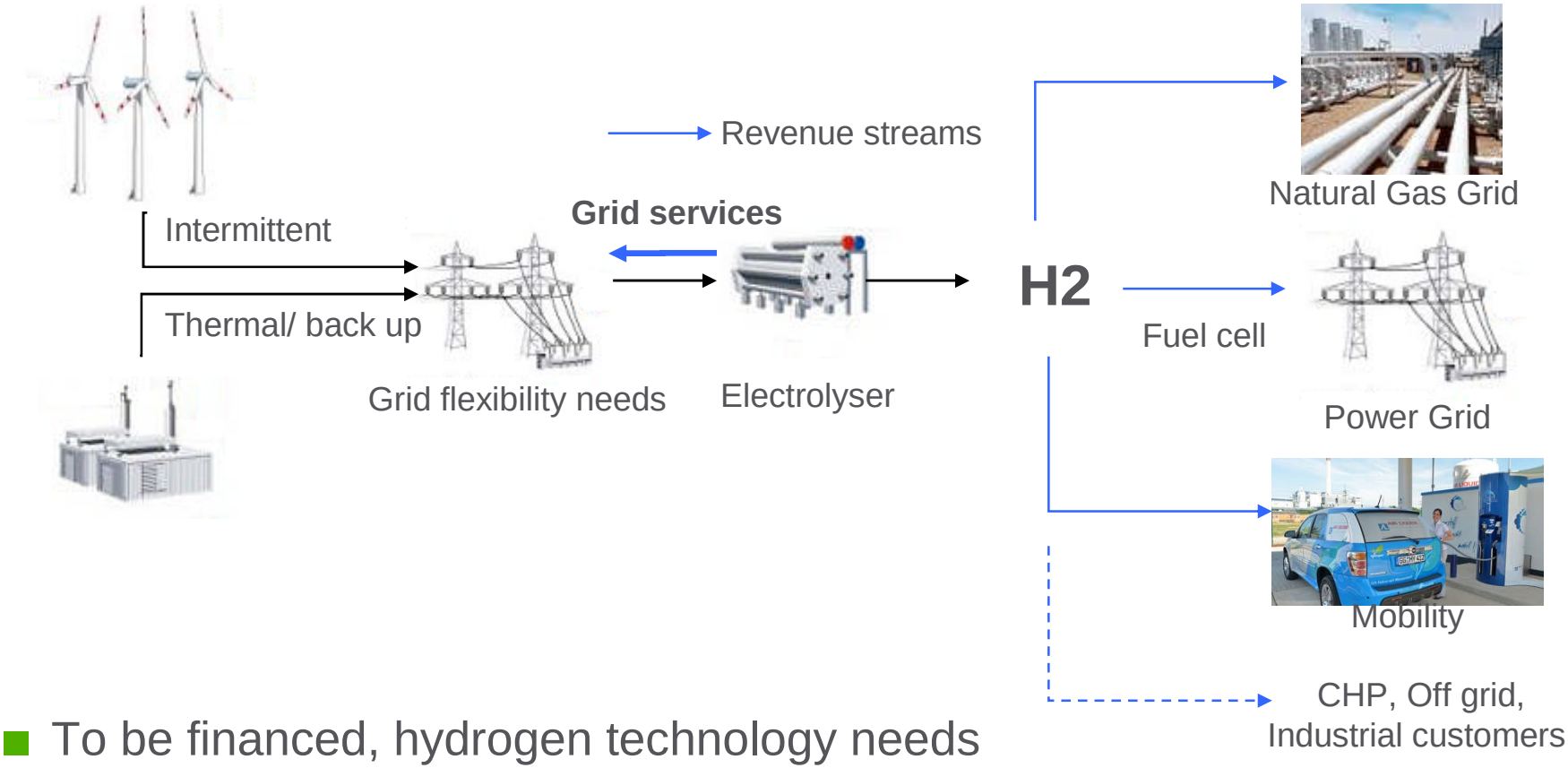
Pierre Etienne Franc l Air Liquide, Technologies of the Future Director – Chairman of the FCH JU Governing Board
Sevilla, November, 16th 2012 l IPHE Conference

Renewable move means a shift in the energy models - from OPEX to CAPEX

- Conventional power scheme
  - Low CAPEX per MW (Nuclear exc.)
  - High OPEX
  - SPOT price ~ marginal cost of the last power plant brought online

- Renewable energy new paradigm
  - CAPEX rises
  - OPEX decreases
  - Production marginal cost ~0€/MWh
  - Competition with other mature or developing technologies for access to capital markets
- Similar financing issues for **substitution** technologies
  - High CAPEX at start
  - High market risks requiring new business models and supporting mechanisms to develop:
    - New energy storage technologies
    - Hydrogen infrastructure for mobility

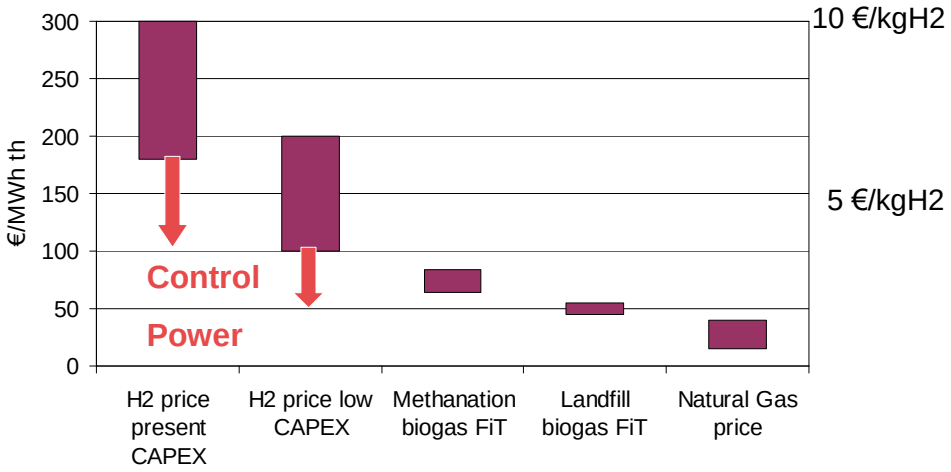
Versatility of Hydrogen is a key advantage for energy storage



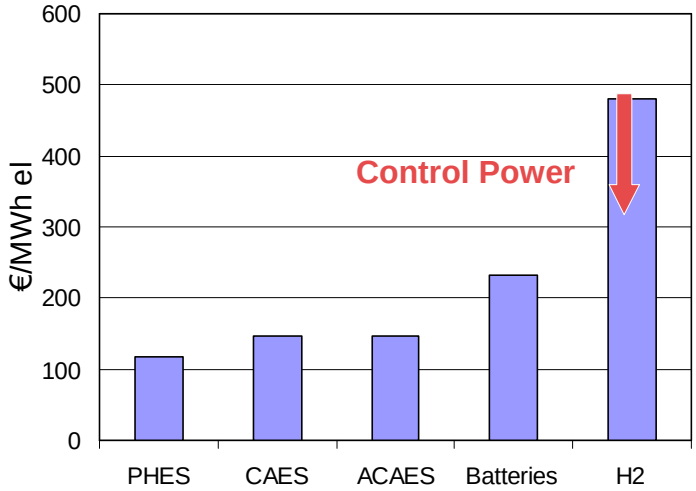
- To be financed, hydrogen technology needs
  - A **sound business model**: Appropriate applications for **decarbonised H2**
  - **Political vision and support** for new substitution technologies

Power-to-power and power-to-gas currently face strong competitive hurdles

- Case 1: Injection in Natural Gas grid
  - H2 valued for its heat value in competition with Natural Gas
  - H2 price derives from
    - Power cost
    - Operating time
    - Electrolyser CAPEX



- Case 2: Reconversion and injection in the power grid
  - Competition with
    - Alternative flexibility solutions
    - Other storage technologies
  - Daily price arbitrage business case

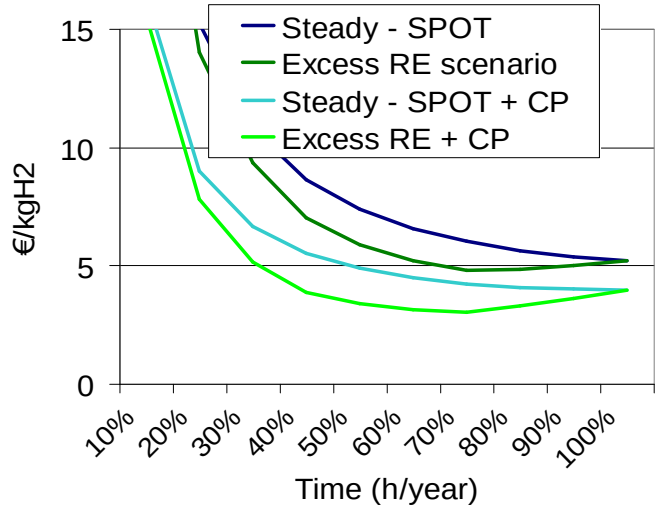


➔ Hydrogen competitive if low electrolyser CAPEX and high remuneration for control power

Steady electrolysis or discontinuous operation?

- Electrolyser hypotheses
  - Low electrolyser CAPEX: 1.5M€/MW
  - Capital charge: 20% CAPEX
- Electricity market hypotheses
  - German day-ahead SPOT- EPEX
  - Theoretical future energy prices

- Electrolyser run when excess RE
  - Operating time & electricity price decreases
  - Cost of capital increases
- Compatible with control power services

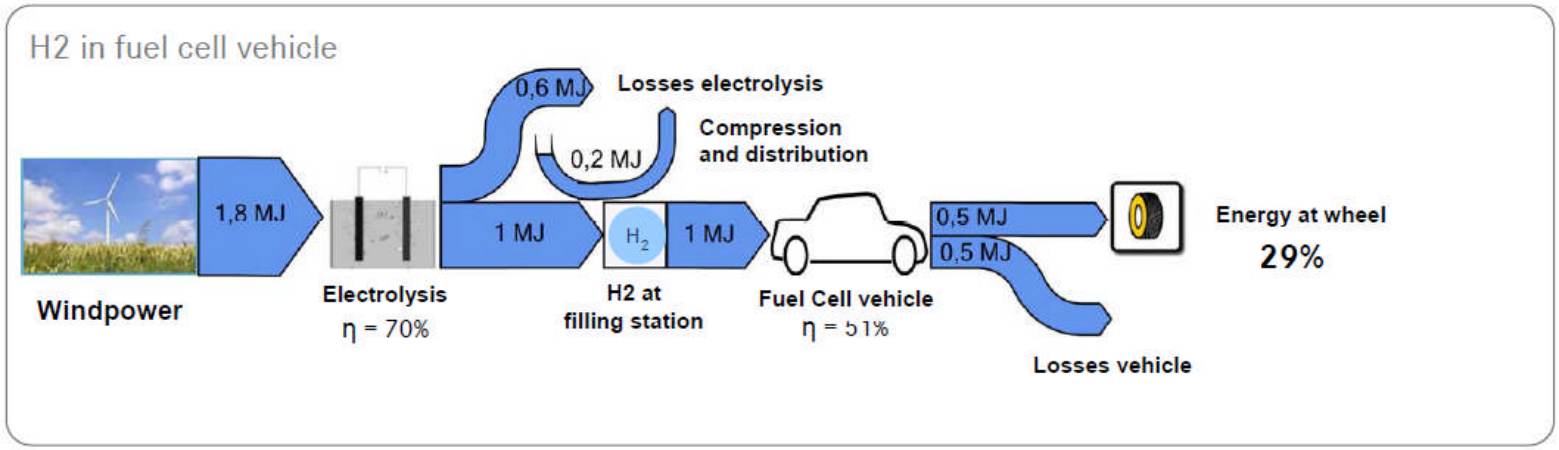


➔ Only low CAPEX and large amount of excess RE enable discontinuous mode

Downstream applications for H2 from energy storage

- Already competitive: **H2 Forklifts**
- First large FCEV developments in Germany: CEP, H2 mobility
- **FCEV are expected to be cost competitive by 2025**
- Decentralised applications
- Competitive Value for H2 (~10 €/kg)

Air Liquide's HRS in Dusseldorf



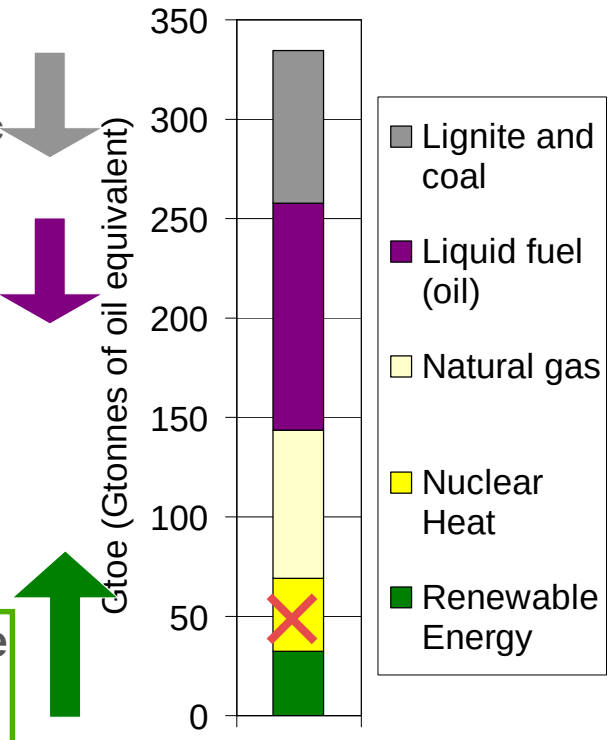
Source: Daimler

➔ Decentralised production for mobility applications consistent with H2 value

Hydrogen transfers Renewable Energy into decarbonised Transports

- Fluctuating RE **curtailment** estimate in 2020 in Germany is 28 000 GWh = 4.5% German electricity consumption
- Conversion in hydrogen by electrolysis
  - 500 000 t H2 that could feed **4.2 millions Fuel Cell Electric Vehicles** ~10% of German car fleet
- Avoided imports: 25 millions of barrels
- **2.8 b€/year** imports avoided at current barrel price (113€/barrel at London Stock Exchange in September 2012)
- Objective in 2020 in Germany: 250 HRS ~Capital Expenditure 2012-2020 ~ **0.5b€**

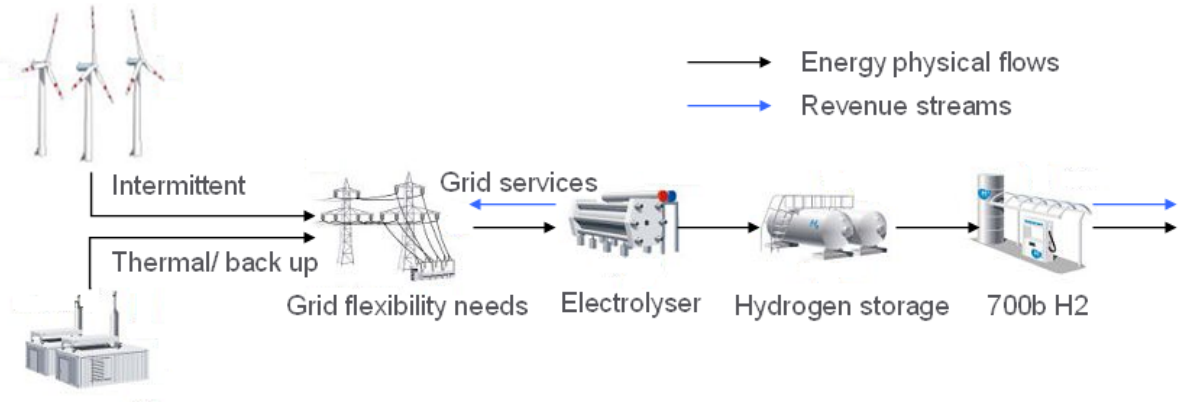
1. **Increasing electricity generation from renewable energy**
2. **Electrolysis to convert excess electricity into hydrogen and stabilize the grid §**
3. **Decarbonise the transport sector**
   - **No dependency to liquid fuel**



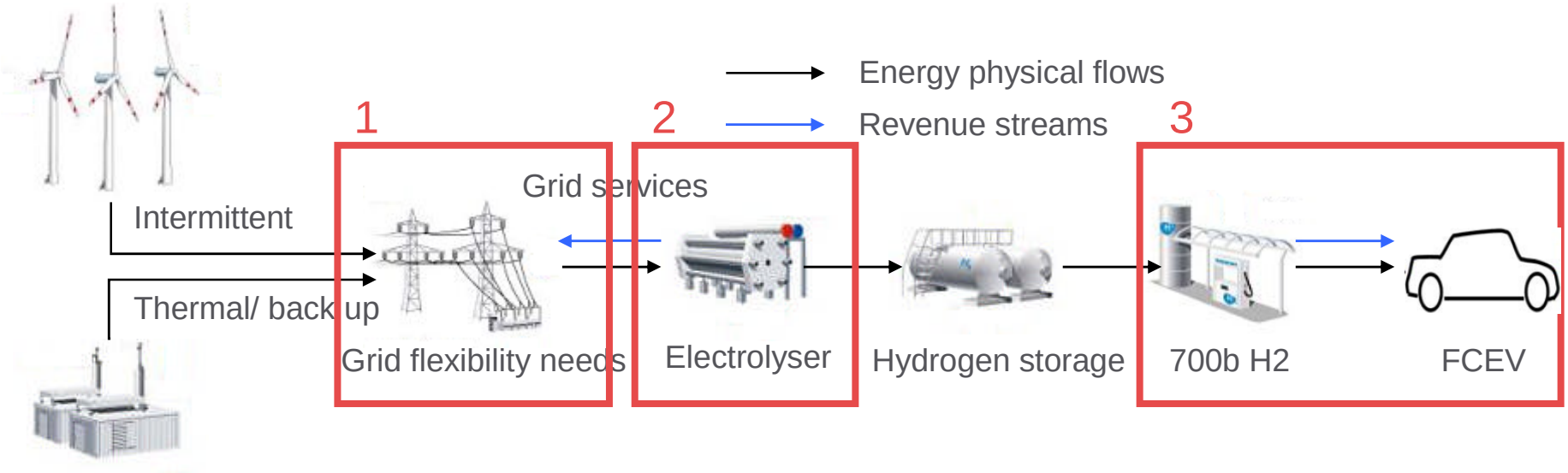
Gross German energy consumption in 2010
Source: Eurostat

Hydrogen business cases are not “bankable” today

- Large scale storage of hydrogen is not an attractive business case today, because it has to compete with competitive “non-zero” emissions technologies
  - Grid extension, conventional back up and wind curtailment are more cost effective
- Industrial / FC applications of hydrogen will drive first developments of hydrogen energy
  - H2 has more value in mobility applications than power-to-gas and power-to-power applications
- Electrolyser flexibility improves the model with Control Power revenues over a steady run mode.



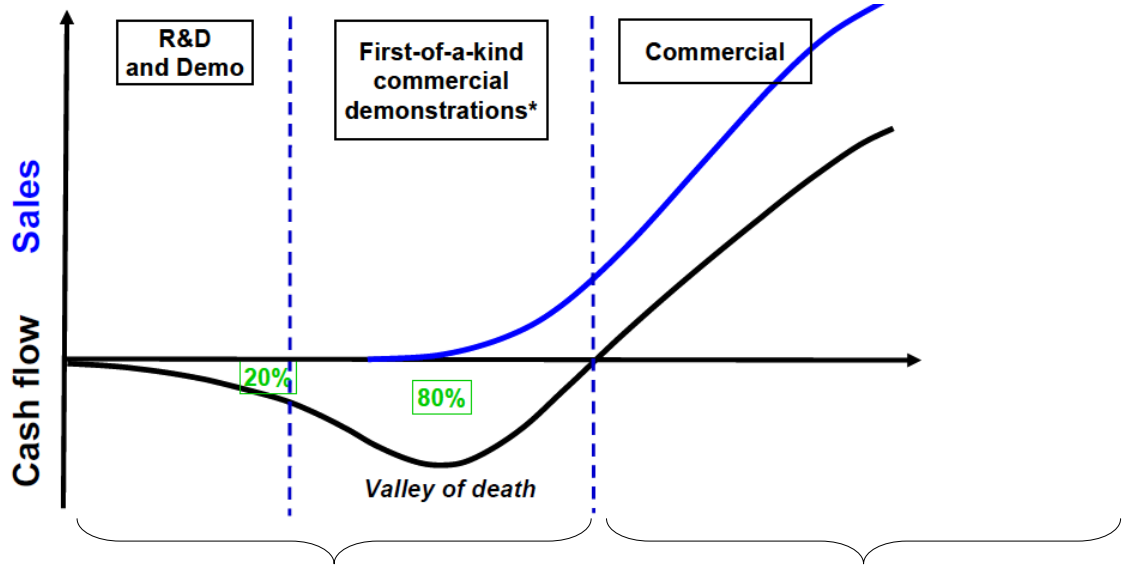
Key factors for a “bankable” project – public support needed



1. Provide a market structure for zero-emission technologies stabilizing the grid
   - Regulation: Lower the threshold (nb. of MW) to be eligible to control power market
   - Financial: Incentivise control power provided by new “zero emission” technologies
2. Support technology development and demonstration projects
   - PEM technology, capex reductions
   - Examples: Joint Undertaking schemes, Oséo
3. Develop direct applications of hydrogen as mobility
   - Incentivise FCEV cars to create a demand for H2
   - Facilitate HRS development through local support and financial tools

Political vision and support to reach cost-competitiveness

- Market and technology risks are high →long term vision
- Investment cannot be carried only by private actors without political support: public-private partnership
  - Direct funding: R&D and demonstration e.g. JTI
  - Reimbursable grants: First-of-a-kind and commercial demonstration
  - Feed-in tariff, loans guarantees, tax credit for commercial developments



Examples **FCH JU, Nat. Programs** **Feed-in-Tariffs for renewable energy**

Public/Private partnership for hydrogen infrastructure

- Needs to de-risk private investment through public support
  - Loan guarantees, Co-financing, insurances, state loans,….
- Tackling the first mover disadvantage
  - Capital intensive developments vs. low utilisation rate at start
  - Need of protection for early movers / No barrier to entry for future stakeholders
- Need for public private advanced collaboration
  - Share first development costs & risks
  - Create temporary dispensations to competition regulation (as for Mobile Phone Networks)
  - Support of European and national institutions through direct subsidies, guarantees, regulation, codes and standards, public incitation, support to public equipment

Thank you for your attention