Opportunities in the hydrogen value chain
Study goal and definition of supply chain

- What are the most relevant and interesting parts in hydrogen (electrolyser) supply chain? Where are market opportunities?
- What are existing and potential players?
- What are the challenges of this industry?
- How can RVO together with knowledge institutes support industry?
Segmentation of supply chain:
1. inventory of system-market-combinations and OEM/manufacturers

- E-production
- Mobility: vehicles and tank infrastructure
- Chemical industry (feedstock and HTH)
- Built environment and agro
- Pipeline (backbone & distribution)
- Ship
- Rail
- Road
- Salt domes & system
- High pressure storage/transshipment
- Storage/transshipment liquid H2
- H2 carriers
- Alkaline electrolysis
- PEM electrolysis
- Small scale / local
- Hydrogen windmill or PV-installation

- Export
- Hydrogen use
- Transport and distribution
- Storage / transhipment
- Import
- Hydrogen production (+import)
- Raw materials

Out of scope: E-production, Biomass

Education and training

R&D

Standardization & inspection
Segmentation of supply chain:
1. inventory of system-market-combinations and OEM/manufacturers

- **E-production**
- **Bus, truck, HRS, bunker station**
- **Chemical industry (feedstock and HTH)**
- **Built environment and agro**
- **Pipeline (backbone & distribution)**
- **Tank ship, harbour**
- **Rail**
- **Road**
- **Salt domes & system**
- **Pressure tanks and compressors**
- **Storage/transhipment liquid H2**
- **H2 carriers**
- **Alkaline electrolysis**
- **Electrolysis plant, incl. demi water**
- **Small scale / local**
- **Hydrogen windmill or PV-installation**

- **Export**
- **Import**

**Out of scope:** E-production, Biomass

**Hydrogen use**

**Transport and distribution**

**Storage / transhipment**

**Hydrogen production (+import)**

**Raw materials**
Segmentation of supply chain
2. Market players for each system and life cycle step

- **Design:**
  - Mobility: vehicles and tank infrastructure
    - Car manufacturers
  - Built environment and agro
    - Manufacturer boilers, heating solutions
  - Industry
    - Engineering companies

- **Build:**
  - Car manufacturers
  - Manufacturer & installation companies
  - Project management companies

- **Finance:**
  - Lease company, consumer, operator
  - Consumer, energy provider, housing corporation
  - Industry/operator

- **Operate:**
  - Bus & transport companies, tank station operators
  - Consumer
  - (Petro)chemical industry, basic metal, refineries

- **Maintain:**
  - Car garage
  - Installation companies
  - MRO-companies

- **Recycle / Dispose:**
  - Car demolition company

**Products**

**Specific services: software, financing**
Segmentation of supply chain:
3. Top-down decomposition

PEM electrolysis system (example)

General: AC/DC, thermal & fluid management, water treatment, H2-conditioning.
Specific: PEM electrolysis stack

General: housing, cooling, piping
Specific: Gas-drying, reverse osmose, de-Oxo, H₂ flowmeters, sensors, valves

General: fixtures
Specific: gas diffusion layer, membrane and gaskets etc.

General: composites, RVS, aluminum
Specific: coatings, alloys, fibers.
Detailed built-up for PEM electrolyser system

Many components, parts and materials are also part of other hydrogen and non-hydrogen supply chains, increasing market potential.
Search criteria for opportunities and promising segments

- Growth markets with innovation challenge and/or few existing players, preferably with export potential
- Products and services are considered promising when existing companies have a strong position and/or competitive advantage:
  - In relevant markets (share, added value, cluster, assets), such as gas market
  - In relevant knowledge and technology fields
  - In relevant products and services

Hydrogen characteristics:
- Not perceptible with human senses → Sensors
- Small molecule → High-quality materials (alloys), liners, coatings, sealing techniques
- Low density → High pressure, cryogenic, high-tech materials
- Fuel cells → high purity; filtering and separation techniques
### SWOT for the Netherlands (preliminary)

#### OPPORTUNITIES
- Large amounts of North sea wind and spilled renewables offer chance of low-cost low carbon hydrogen
- Green chemicals and refinery may offer large new market
- Many larger OEM’s in Europe, with strong local sourcing
- Costs can be brought down through industrialization
- Some components are part of multiple supply chains (hydrogen and non-hydrogen)

#### STRENGTHS
- Position in several supply chains as subsystem and component manufacturer.
- Knowledge and experience gas and process technology.
- Gas assets and infrastructure
- High tech materials, experience composite materials
- Efficiency, productivity and added value
- Services (optimization & prediction software, financing, testing, logistics)

#### WEAKNESSES
- Limited number of OEM’s in value chain
- Technical and research personnel
- Dependence on fossil fuels
- Small home market
- Research and development
- Access to scarce and high cost materials

#### THREATS
- Renewable clean hydrogen may not get support to make it competitive.
- Blue and grey hydrogen may have lower costs.
- Insufficient green electricity may be available or at too high costs.
- Industrialization may take place in US or Asia.
- OEM’s may build their own capabilities for critical components
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**Defend**
- Increase investments in wind energy, develop hydrogen hotspots near landing points, convert gas infrastructure.
- Seek for cooperation with OEM's, invest in training & education.
- Develop import and export position in hydrogen.

**Attack**
- Focus components and materials, in particular those that appear in multiple chains and some specialized PMC's.
- Strengthen focus components and materials, in particular those that appear in multiple chains and some specialized PMC's.

**Strengthen**
- Defend
- Withdraw
Questions (workshop):

1. Why are costs too high?
   - Number of suppliers
   - Production costs (low automatization, low volume)
   - Logistic costs (worldwide components supply
   - Material costs
   - Technological maturity
   - ..... 

2. What are opportunities for electrolyser supply chain in the Netherlands?

3. How can RVO support development of the supply chain?

4. May we contact you?