Hydrogen Promotion Initiatives in Portugal

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Promotion of H_2 in Europe

- EC funding H&FC projects since 80´s
  - High Level Group for Hydrogen & Fuel Cells Technologies : **October 2002**
  - Hydrogen & Fuel Cell Technology Platform : **January 2004**

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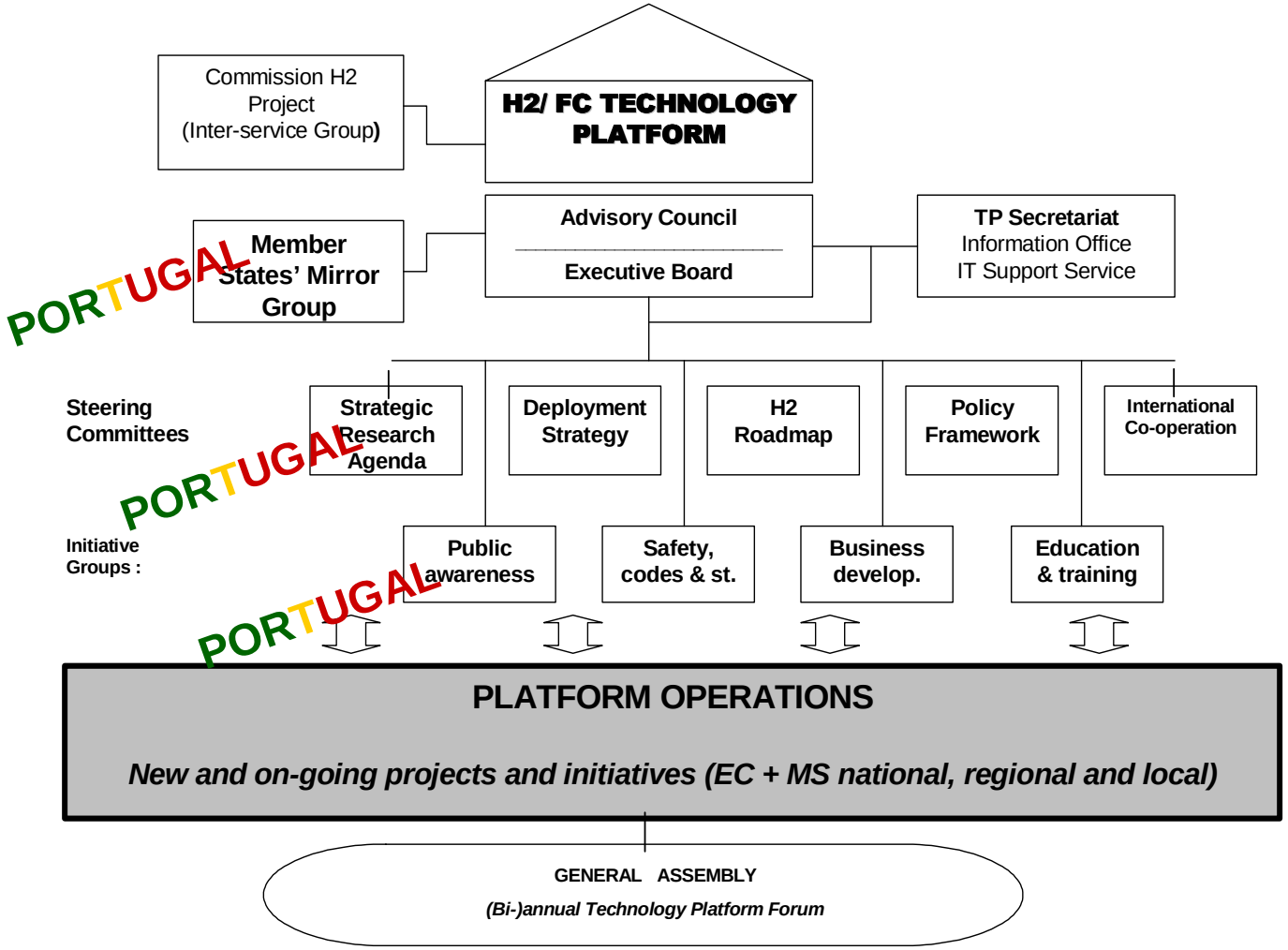
Participation in HFP



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H_2 related projects in Portugal

- Demonstration:
  - CUTE
  - Virtual Fuel Cell
- Policy:
  - HySociety
  - HyNet
  - HyWays
  - HyCo

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H_2 demonsrtations in Portugal

Demonstration

- CUTE
- Virtual Fuel Cell Power plant

Launch of CUTE Project

Porto Portugal

10th January 2004

Hammerfest (NO) - Lisbon (PT) 10,000 km Marathon

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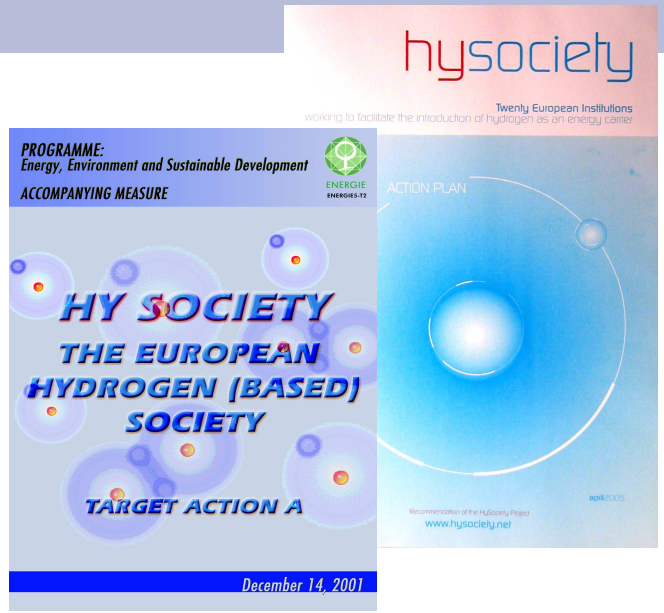
H_2 policy-related Projects

Policy:

- HySociety
- HyNet
- HyWays
- HyCo

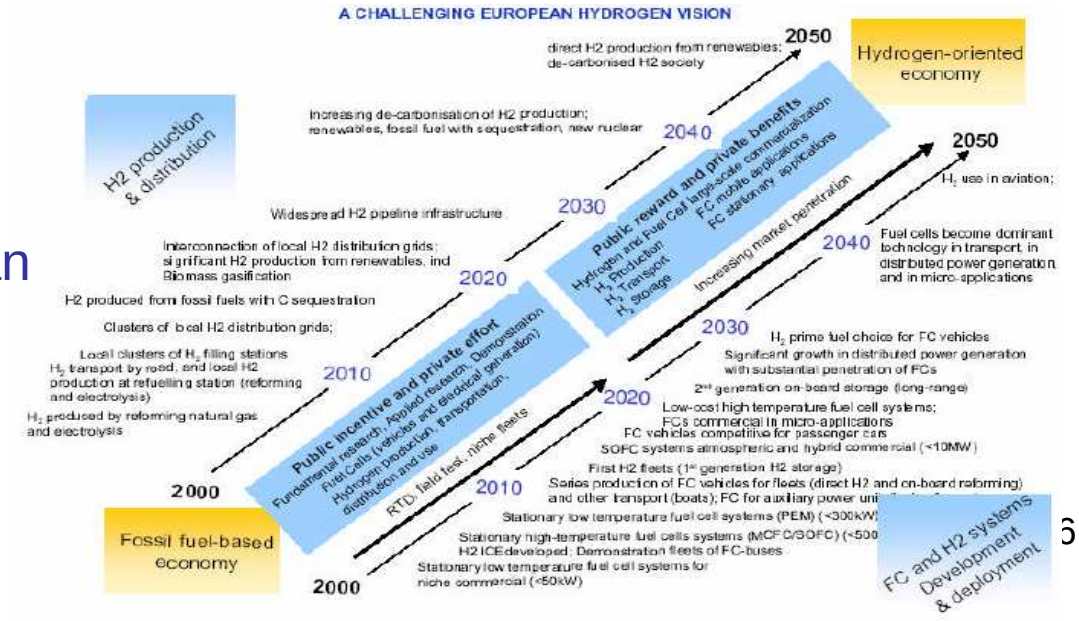
HySociety

- 2002-2005
- Coordination: PT



HyNet

First-stage European H_2 Roadmap



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H_2 policy-related Projects

Policy:

- HySociety
- HyNet
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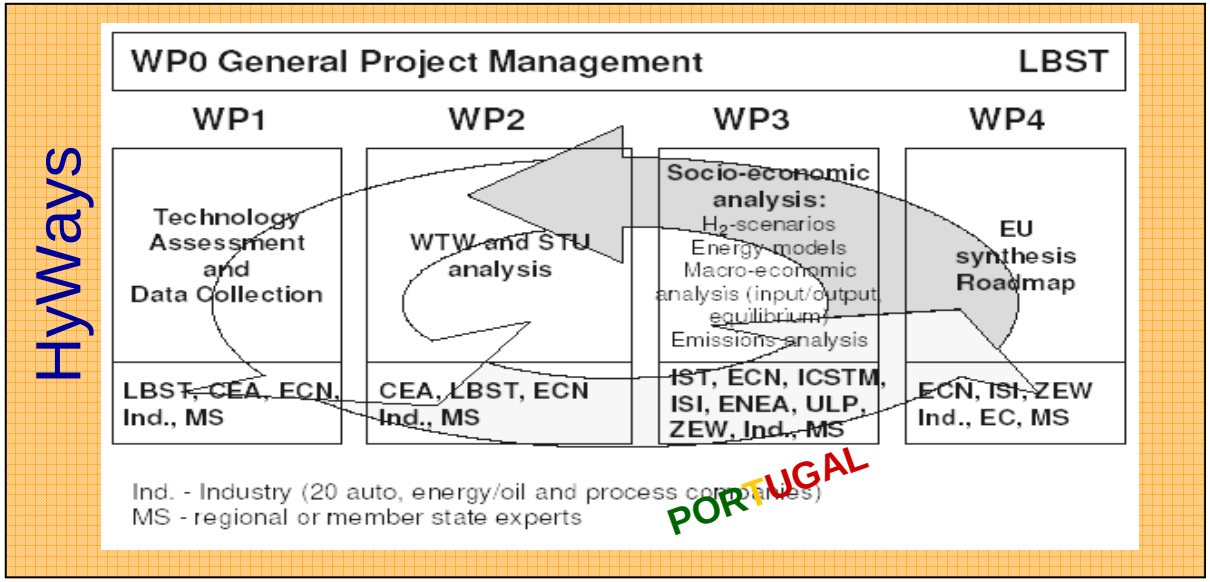

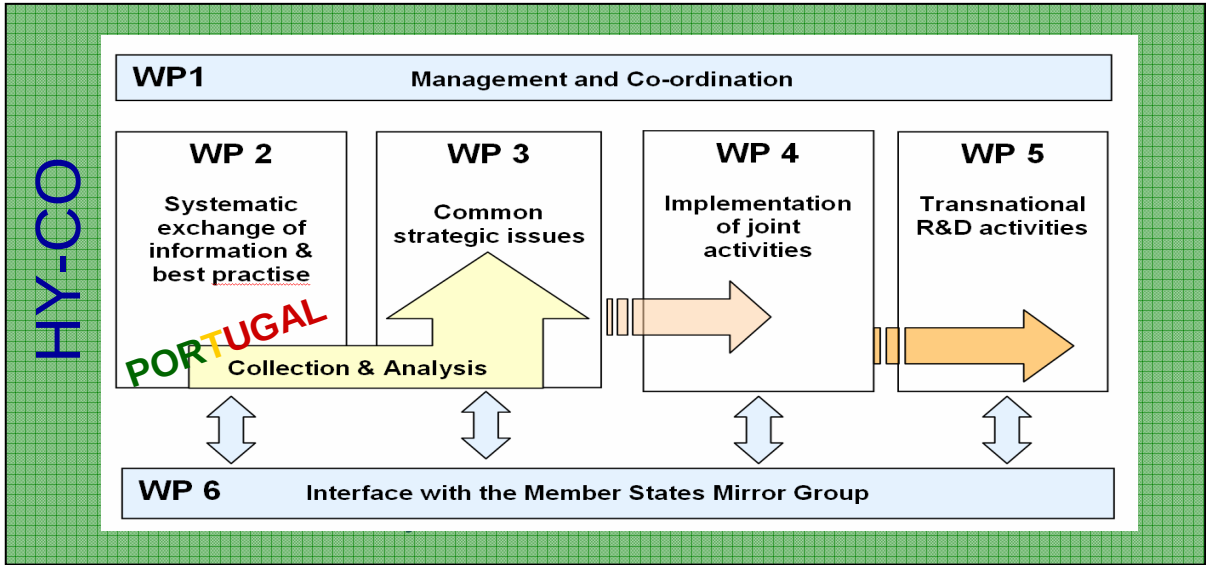

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Initiatives in Portugal

- 2003
- 2004: Évora

- 2005: II Forum

AP2H2
Associação Portuguesa para a Promoção do Hidrogénio

- First meeting focused on H_2 energy systems for Portugal
- Initial brainstorming
- Questions & needs

Debate

- Industry: market opportunities
- Government:
  - H_2 meeting Govt. policy targets
  - Incentives
- Research: mechanisms required
- Vision : future energy mix
  - Renewable energy targets
  - Import dependency

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Some National H_2 Related Projects

- Technology Platform
- H2REM
- Promotion & Dissemination of H in PT
- Green Hotel
- Hi-Po
- EDEN
- Transnational call (HY-CO)
  with DK, NL, SL, FR & PT

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The Hi-Po Project

National Strategy for the Development of Hydrogen as an Energy Carrier in Portugal

- By building and evaluating scenarios with stakeholders for the future of hydrogen in Portugal
  - not prediction of future
  - study of consequences of possible futures, to help in the decision making process
- Scenarios or pathways to be used in EDEN project for Roadmap for Portugal

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Methodology I

1. SCOPE
   - Literature review
   - Extended list of stakeholders
   - Stakeholders' meetings for the definition of methodology
2. SCENARIOS DEVELOPMENT
   - Scenarios workshop
   - Scenarios development
   - Consultation with experts
   - Final set of scenarios

Methodology II

3. MULTI-CRITERIA ANALYSIS

- Definition of stakeholders' panel
- Multi-criteria mapping interviews
- Analysis of the interviews' results

4. PATHWAYS & ROADMAP

- Pathways analysis and contribution for the definition of a hydrogen roadmap

Final set of scenarios

1. Dominant renewables
2. Centralized non renewable and bioenergy
3. Decentralized electricity
4. Decentralized natural gas
5. Small scale and liquid fuels

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Scenarios 1 & 2

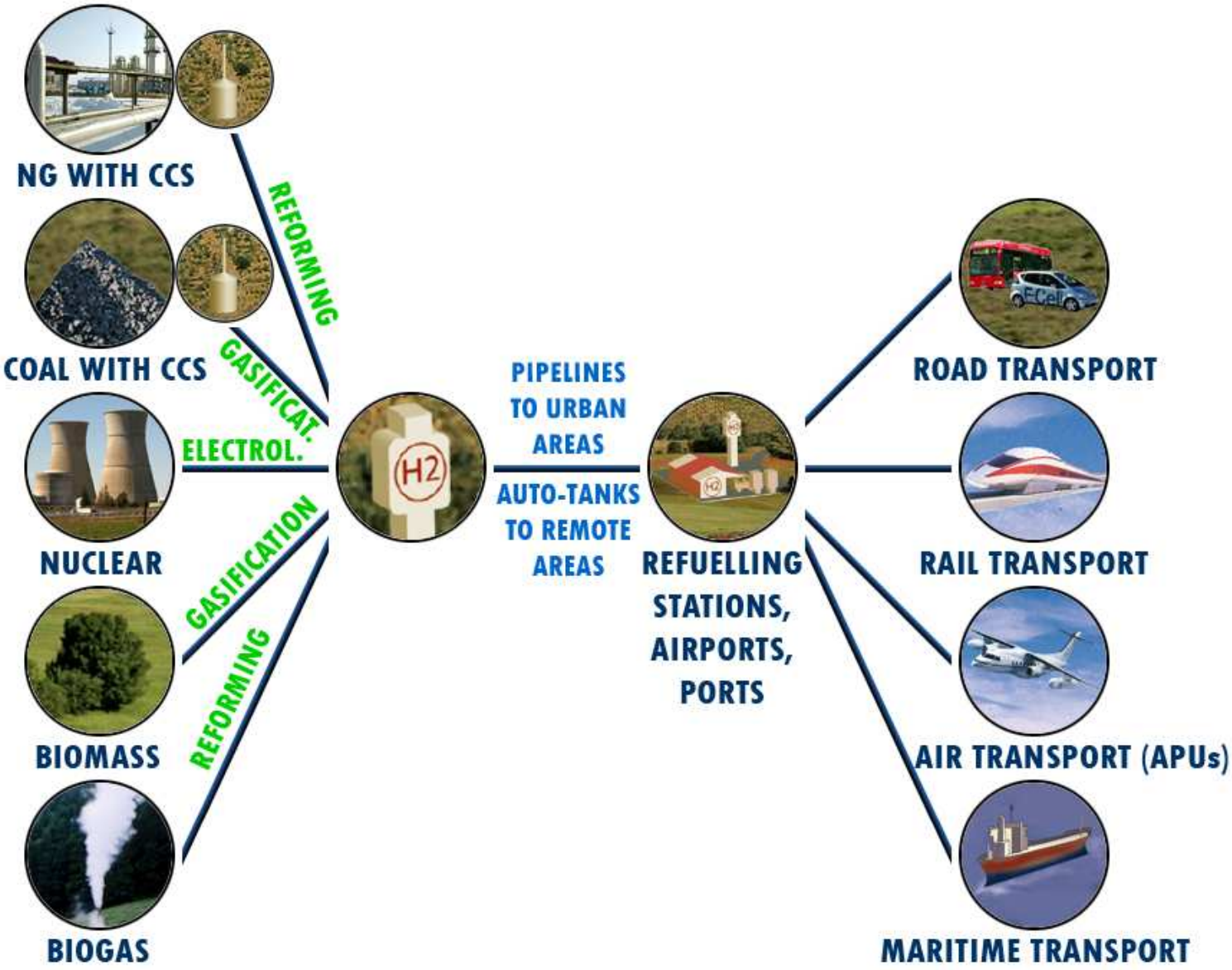
1. Dominant Renewables

- centralized production of hydrogen
  - based exclusively on renewable energy sources
- distributed by pipelines to refuelling stations
- for transport, industry & residential uses.

2. Centralized non renewable & bioenergy

- centralized production of hydrogen
  - based on natural gas & coal, both with carbon capture and storage (CCS), nuclear, biomass and biogas
- distributed by pipelines to refuelling stations, airports & ports for transport use

2. Centralized non renewable & bioenergy



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Scenarios 3-5

3. Decentralized electricity

- decentralized production of H_2
  - electricity grid - on-site electrolysers for road transport, industry & residential CHP

4. Decentralized NG

- decentralized production of H_2
  - NG grid - on-site reformers for road transport.
  - Coal power plants with CCS - hydrogen for nearby refuelling stations and industries

5. Small scale & liquid fuels

- H_2 for remote communities based on renewable sources, mainly wind, solar & biomass
  - residential CHP & energy storage for the grid
- Main use of H_2 - production of H_2 rich liquid fuels, such as methanol, which are the dominant fuels for road transport

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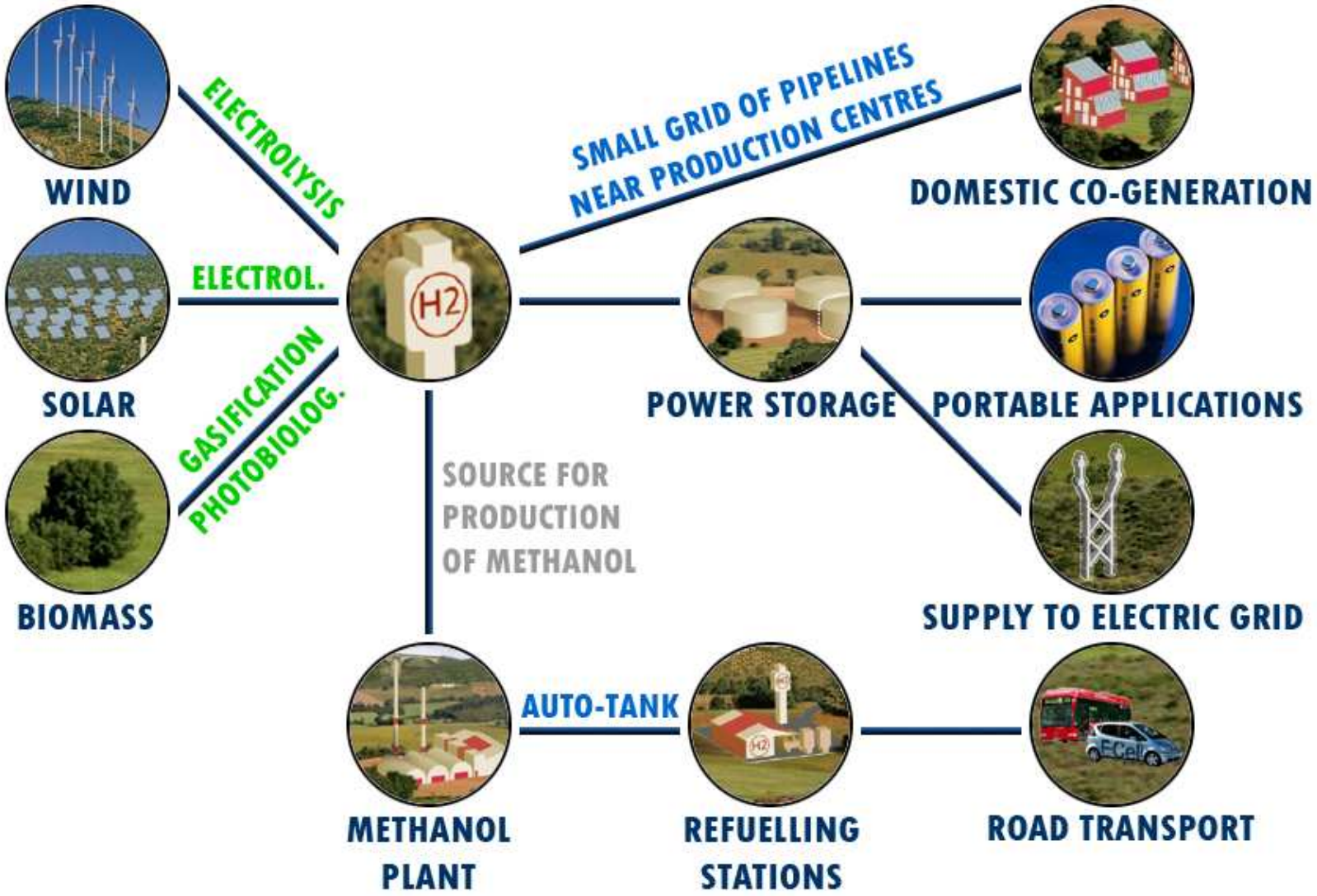
5. Small scale & liquid fuels



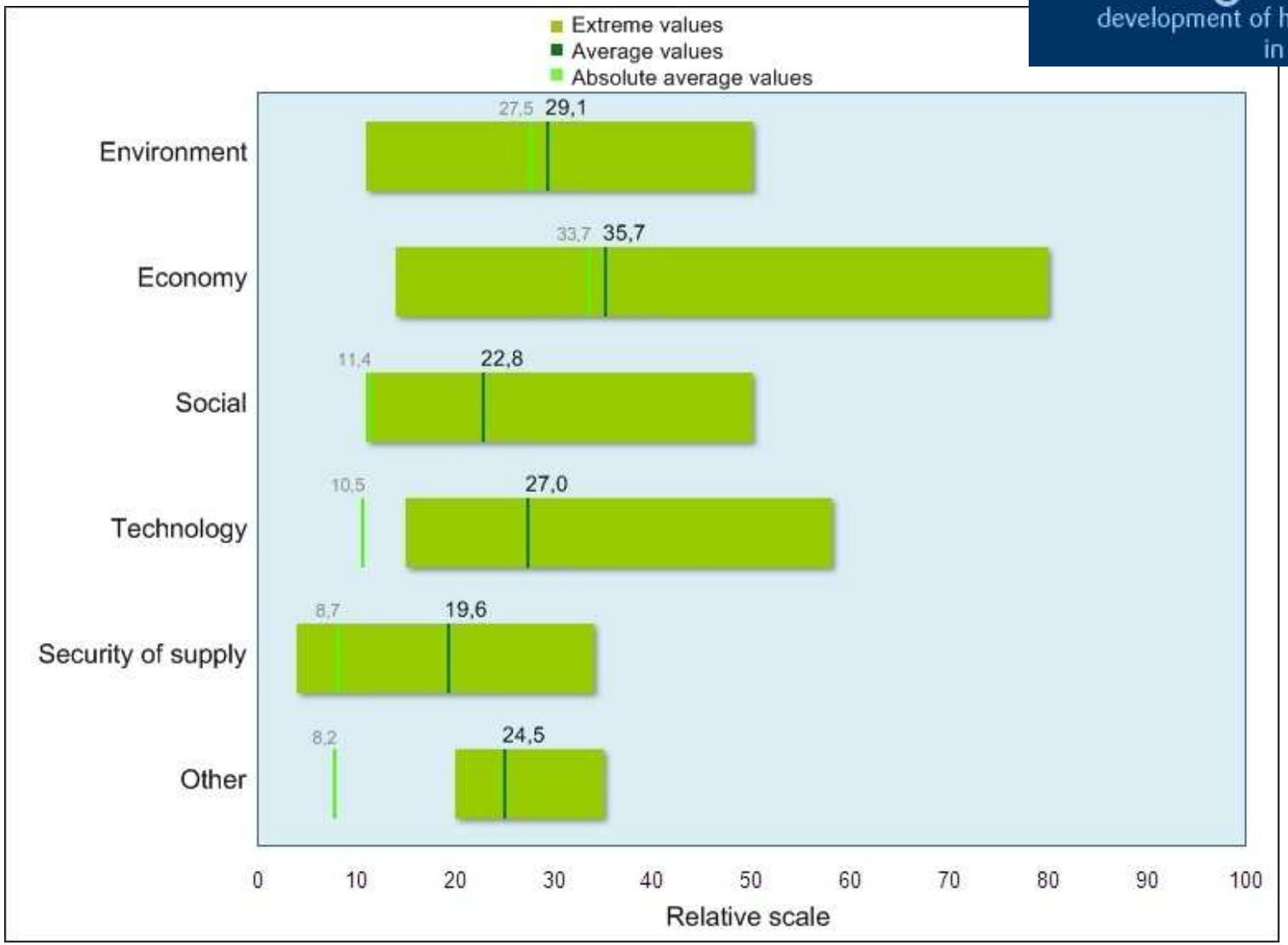
Evaluation of the scenarios

- Five scenarios thoroughly assessed through a multi-criteria mapping process in 18 individual interviews
- Stakeholders asked to create measurable criteria to evaluate the scenarios and to give a weighting to them

Evaluation of the scenarios

- 2-7 criteria created per stakeholder, average of more than 4
- Criteria grouped in 6 categories:
  - Economy (most common: investment and production costs)
  - Environment (emissions, impacts)
  - Security of supply (endogenous resources)
  - Social (public acceptance, diversity)
  - Technology (technological development, efficiency)
  - Other

Evaluation of the scenarios



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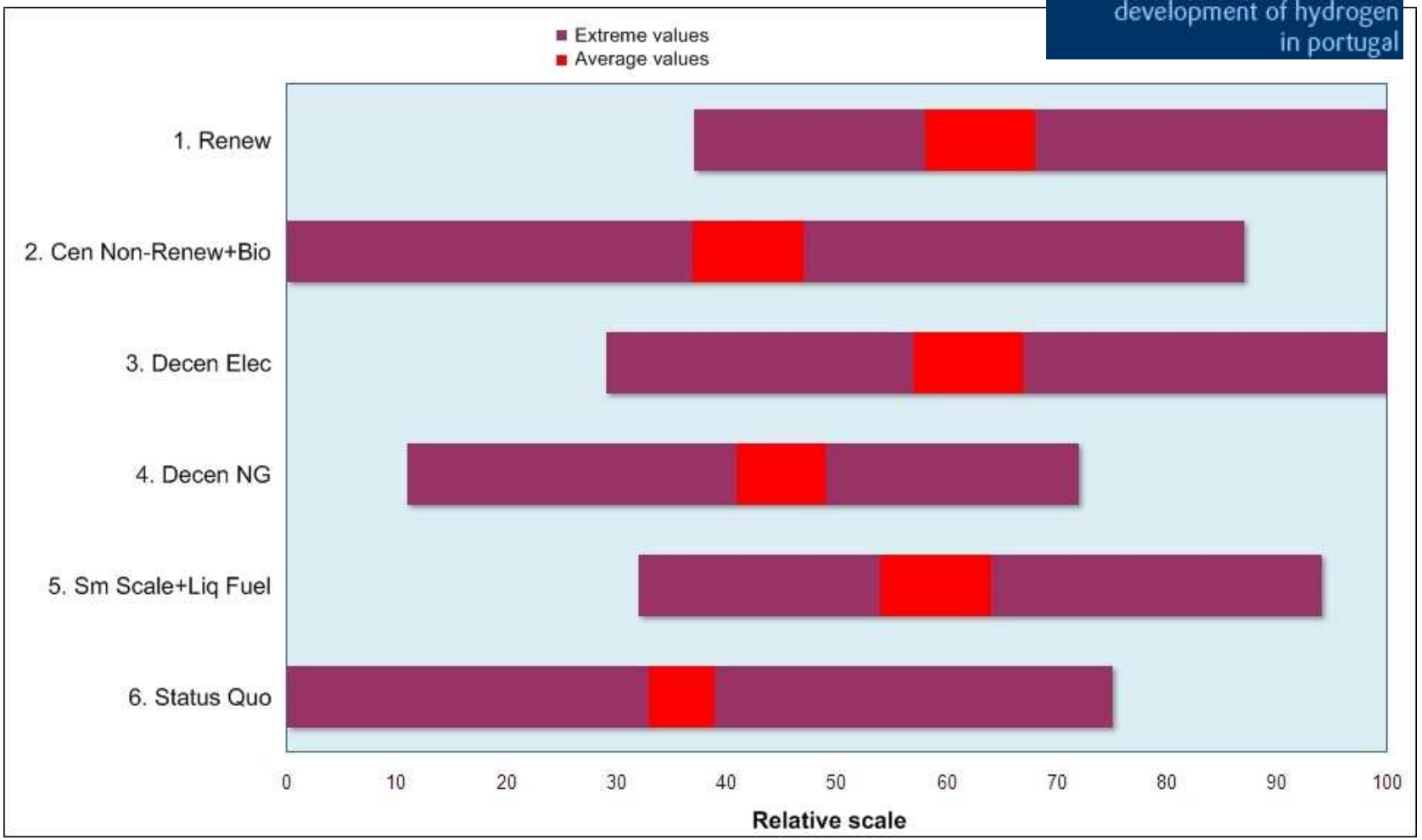
Evaluation of the scenarios

Main conclusions:

- No scenario identified as a clear winner out of the evaluation process
- Dominant idea across most of the stakeholders is that the future of hydrogen in Portugal will not be focused on any of these scenarios but on a mix of several
- Stakeholders more concerned about the challenges that the hydrogen economy has to face, rather than highlighting its opportunities. This is evident in the higher weights given to economic and technological criteria over the environmental and security of supply ones

Evaluation of the scenarios



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Evaluation of the scenarios

Sources:

- Renewable sources should have a prevailing role in the production of hydrogen, namely wind and solar
- Natural gas and coal with CCS mentioned as inevitable sources for the production of hydrogen, due to its availability and low costs
- Nuclear far from being a political option in the short and even in the long term for Portugal

Evaluation of the scenarios

Production & distribution:

- No clear preference for centralized or decentralized production of hydrogen
- Decentralized advocates stressed this option to be the future of energy production, essentially if based on renewable sources
- Electrolysis as a limiting factor for the hydrogen economy due to its low efficiency

Evaluation of the scenarios

End-Use:

- Road transport rises as a definitive winner for the use of H_2
- Co-generation in industry & residential less consensual, due to the lower efficiency of many conversions
- Pumping water upstream into dams indicated as a more adequate solution than to store power as hydrogen derived from renewable energy sources

Challenges & opportunities

- Costs & technological development
- Foster R&D
  - more efficient & less expensive technologies
  - promote policies to support this energy carrier
- Some stakeholders: costs are a false issue in the time scale considered
  - rising costs of fossil fuel & internalization of environmental impacts will allow more sustainable technologies to become competitive
- Environment & security of supply as main driving forces for the H_2 economy, mostly due to the substitution of fossil fuels
- Positive image of H_2 - stakeholders did not consider public acceptance as limiting factor in PT

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Thank You for your attention

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