

26th World Gas Conference

1 – 5 June 2015, Paris, France



Technological and Economic Aspects of Blending Hydrogen into Natural Gas Pipeline Networks: Determination of Key Issues for a Selected Gas Pipeline in Iran

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Background

Increasing renewable electricity  Reduction of greenhouse gas emission

wind power geothermal photovoltaic



Challenges: fluctuation of energy generation from renewable sources

Methods to use the renewable electricity (Storage):

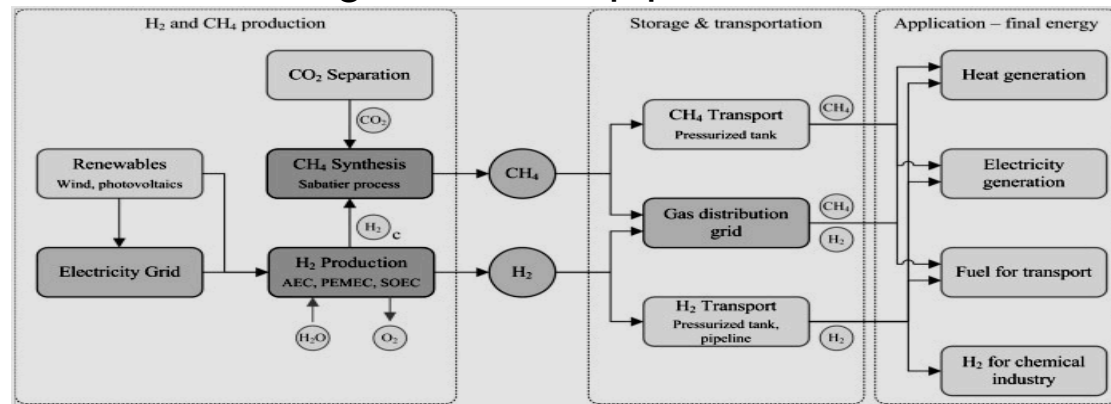
- Storage of electricity by “*pumped hydro electricity storage*” (PHES)
- Compressed air energy storage (CAES)
- Batteries
- *Power to gas*

Background

Power to gas:

- ❑ Convert excess electricity to hydrogen
- ❑ Stored and reconverted H₂ into electricity with fuel cells
- ❑ Hydrogen as an important feed in chemical industries
- ❑ Injection of H₂ into the natural gas network pipeline to the later use

Pathways for
power to gas
system



Technological and Economic Aspects of Blending Hydrogen into Natural Gas Pipeline

Aim

Excess electricity produced from renewable sources



Convert

Hydrogen

- ❖ In-situ use: as a fuel in the H₂-vehicles
- ❖ Add to natural gas pipelines (with limitation)

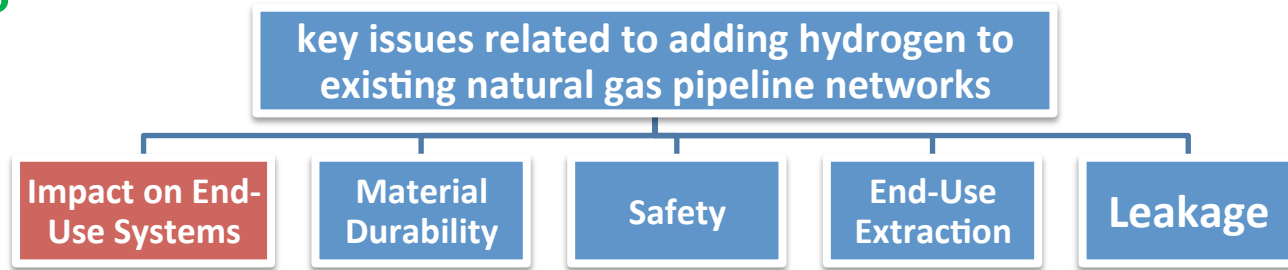


Technical and economic aspects of blending H₂ to the pipelines

Methane

- ❖ Add to natural gas pipelines without limitation

Results



The maximum threshold of mixing hydrogen to the natural gas



We found that within 4%-20% hydrogen, the end-use systems can operate without a large modification.

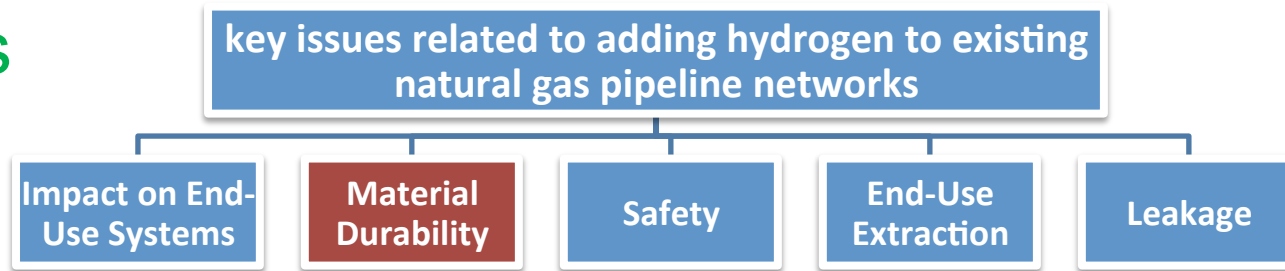


In case of adding 4% hydrogen, the cost of required modification in the sensors is about \$ 500,000 in Iran

Depends on: end-use systems such as household, industrial or power generation appliances

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Results



Physical and chemical effects of adding H₂ on the pipeline



Hydrogen damage

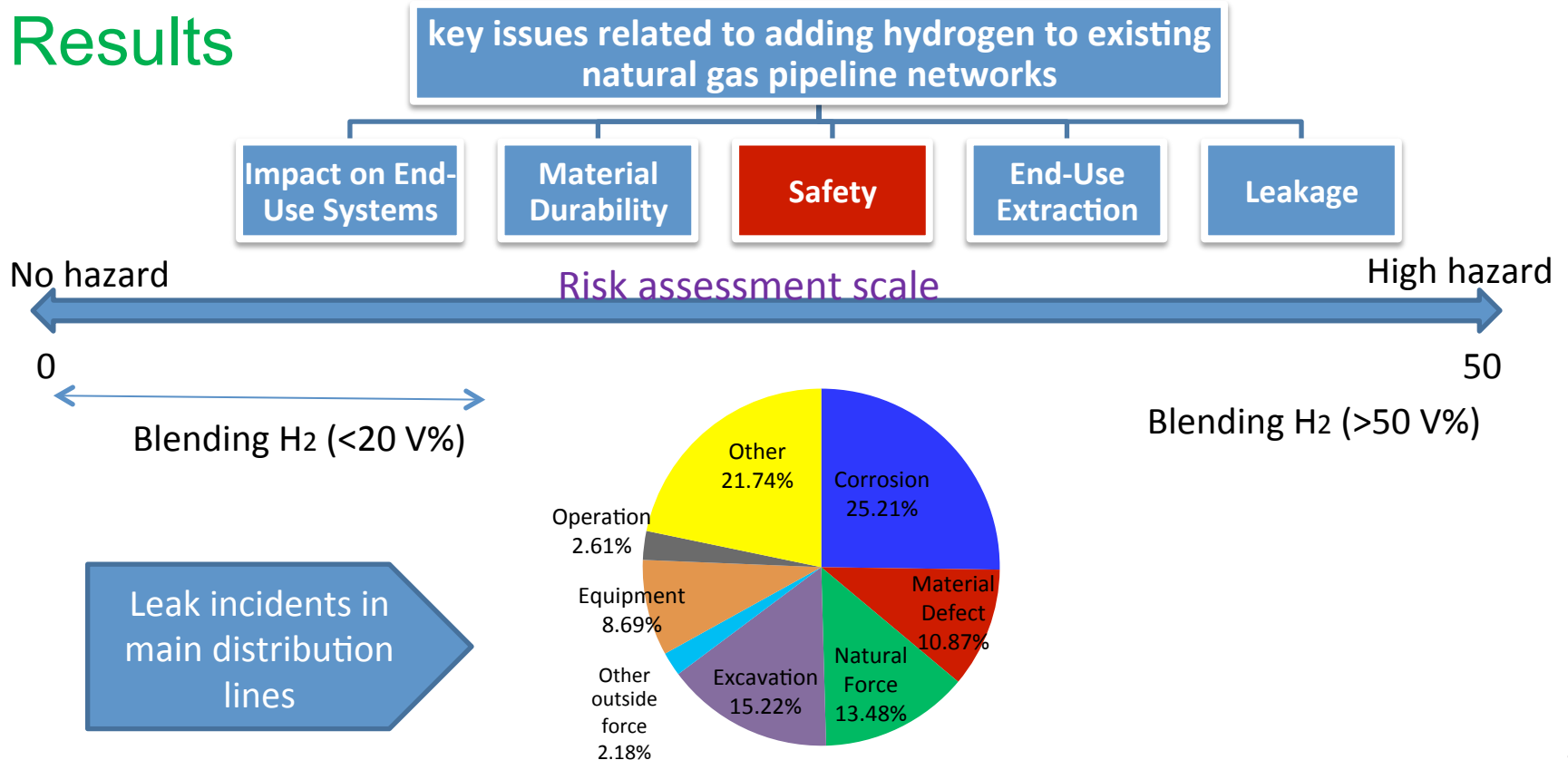


effects on the initiation of defects in the natural gas pipeline

we found that hydrogen permeation through the poly ethylene pipelines are about 4-6 times faster than methane.

Technological and Economic Aspects of Blending Hydrogen into Natural Gas Pipeline

Results



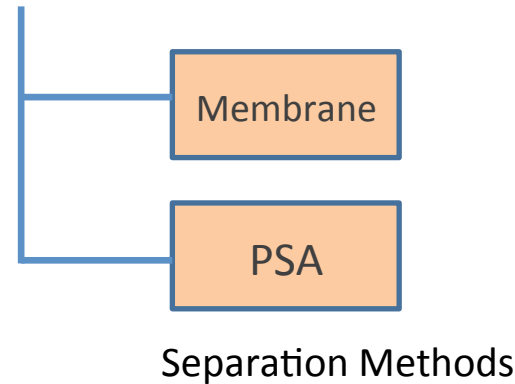
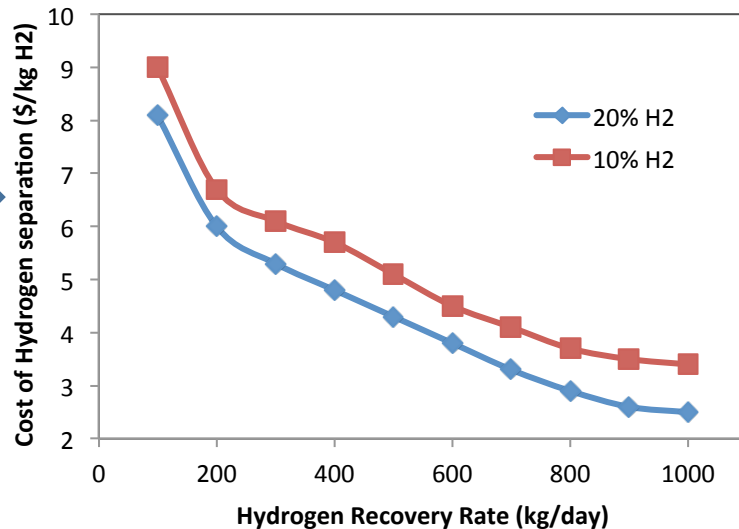
Technological and Economic Aspects of Blending Hydrogen into Natural Gas Pipeline

Results

key issues related to adding hydrogen to existing natural gas pipeline networks

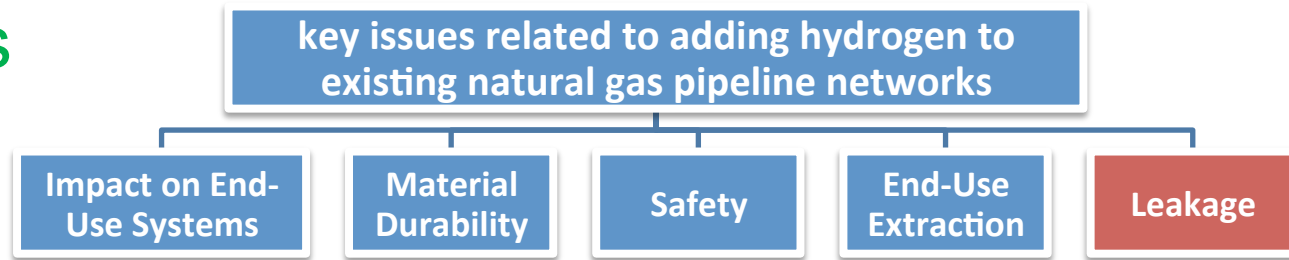


Cost estimation of hydrogen separation by PSA unit from 300 psi natural gas distribution pipeline

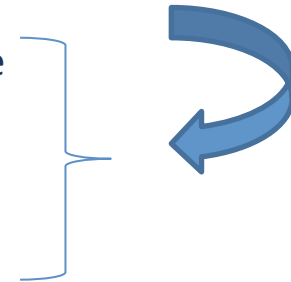


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Results



- ❖ Hydrogen permeation is 4-5 times greater than that of methane
- ❖ The permeation rate increases with pressure for both of methane and hydrogen
- ❖ The aging of pipeline has no significant effects on the leakage from pipeline





Leakage rate for hydrogen and methane from a 20% hydrogen mixture at 5 bar are 2.3 and 1.1 L/(km.day)

Under the same conditions, the permeability of pure methane is 1.4 L/(km.day)

Conclusions

- ❑ Up to 20% hydrogen blending, the end-use systems can operate without a large modification
- ❑ Corrosion and excavation are two frequent leak incidents in the main pipeline
- ❑ In about 5 V% of H₂, no modification would be needed for apply without extraction
- ❑ Blending hydrogen into the natural gas pipelines in order to promote the heating value of the gas is suggested in Iran.
- ❑ Developing the fuel cells and also H₂-vehicles are the other P2G applications in the future.



*Thank you for
your attention*

Q & A