



# problems of forecast

*Dmitry KUCHARAVY, [dmitry.kucharavy@insa-strasbourg.fr](mailto:dmitry.kucharavy@insa-strasbourg.fr)*

*LICIA team*

*INSA Strasbourg Graduate School of Science and  
Technology- LGéCo*

*24, Boulevard de la Victoire – 67084 Strasbourg Cedex -  
France*



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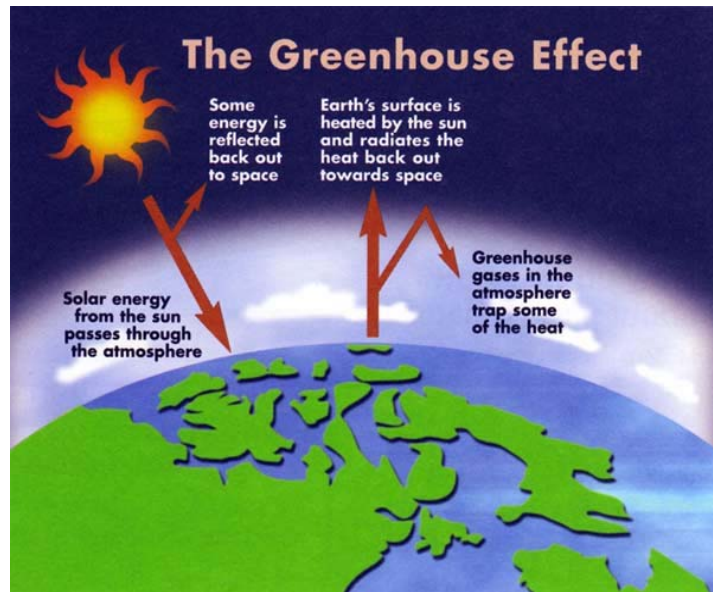
# outline

*"We don't need better solutions, we need better thinking about problems." Russell Ackoff*

- 1. Do we need the technology forecast?**
- 2. Existing solutions**
- 3. Fragment of a Map of problems concerning the technology forecast**
- 4. What has been done to forecast stationary Fuel Cell technology**
- 5. Perspectives**

# 1. do we really need the technology forecast?

*...The only thing permanent is change...*



Source: [www.climatechange.gc.ca](http://www.climatechange.gc.ca)

## Technology forecast efficiency

Low  
(present level)

High  
(target level)

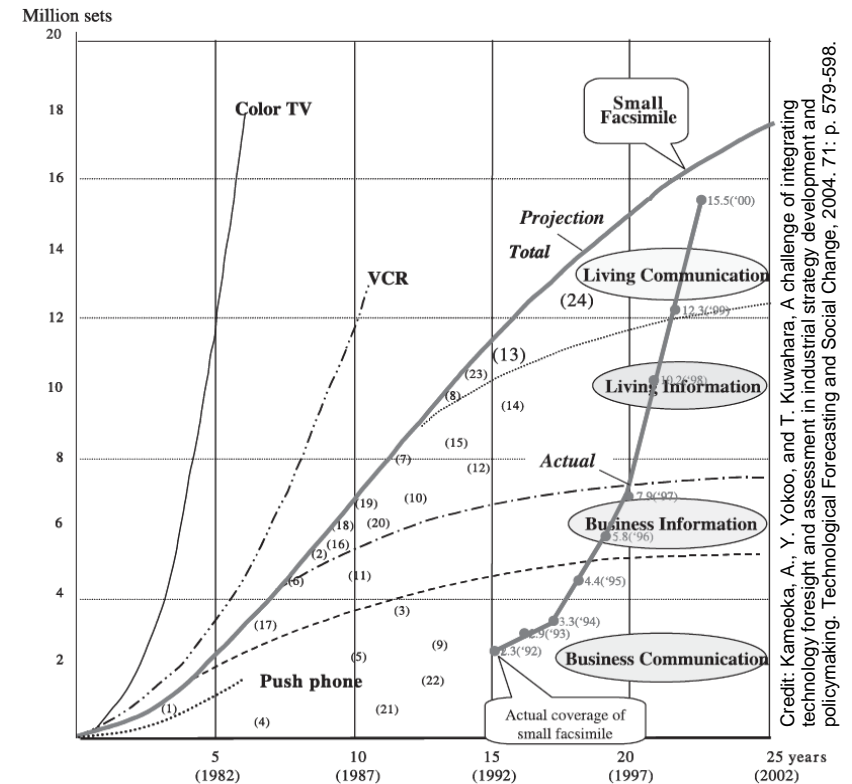
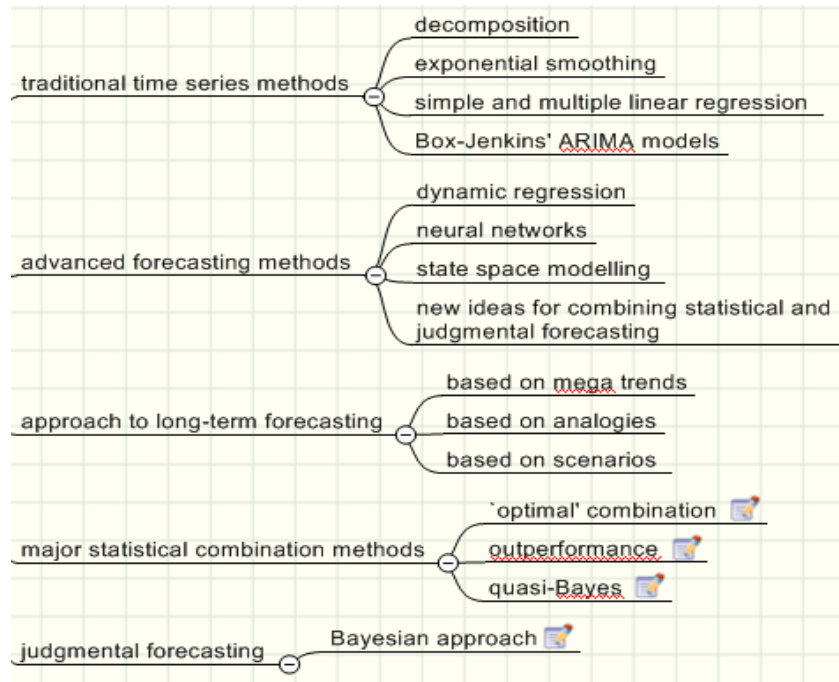
- Necessity to significantly improve the efficiency of Design;  
- No time to develop technologies in response to unpredicted changes ;  
+ Known forecasting methods and processes can be in use

+ Existing Design practice can be in use .  
+ Time and resources available to develop adequate technologies in response to changes.  
- Expenses and efforts to develop a new forecasting methods and processes

*Possibility to develop new technological responses to changes .*

# 2. existing solutions

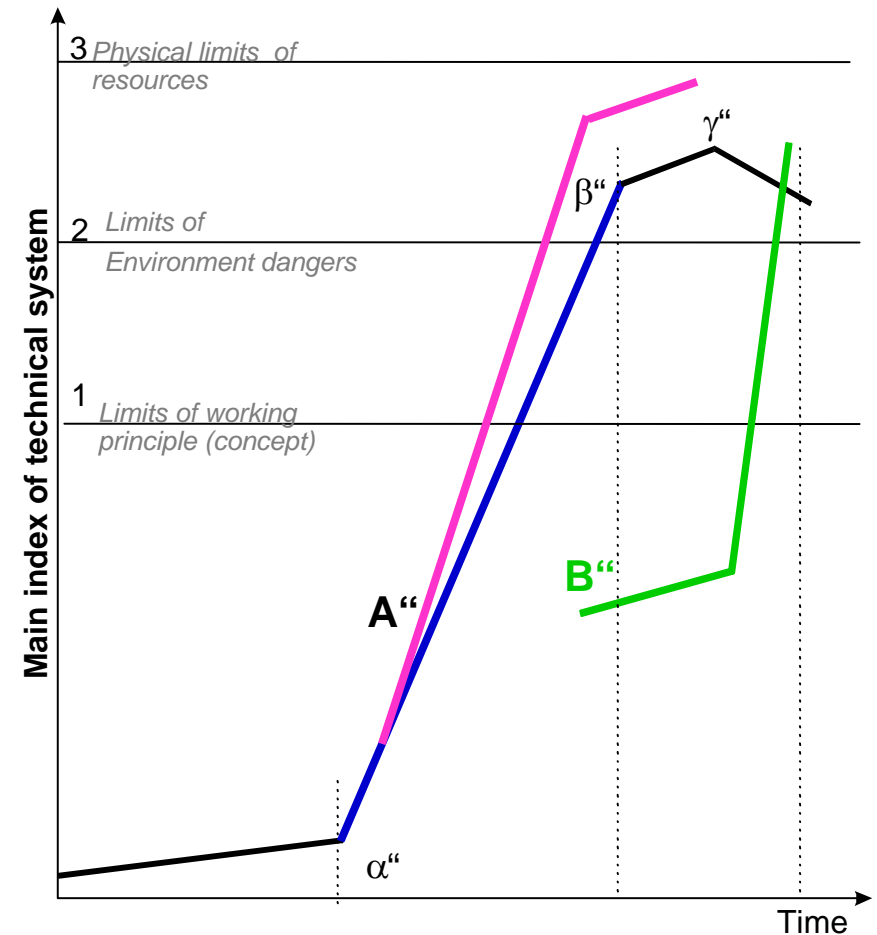
1. Despite many existing methods, middle and long-term technology forecast of a new family of products and new-to-the-world technologies is not accurate enough to validate expenses for forecasting.



# new systems

*"...Any system which depends on human reliability is unreliable..."*  
*Merphy's laws*

- 1. New version of product:** existing product modification (additional performance, reduced cost).
- 2. New market penetration:** existing product for new market.
- 3. New family of products:** existing products with significant improvement of specific feature.
- 4. New-to-the-world product** (pioneering): product has never existed on the market before.



# how to measure the result?

*...How to distinguish the difference between valid and invalid forecasts?...*

$$\text{Efficiency of Technology Forecast} = \frac{\text{Reliable Forecast}}{\text{Aggregated Expenses}}$$

*Reliable forecast* is characterized by the **accuracy** of the forecast and **transparency** of the forecasting process.

*Aggregated expenses* include **resources spent** on the **development** and **communication** of the forecast results.

# preliminary conclusions

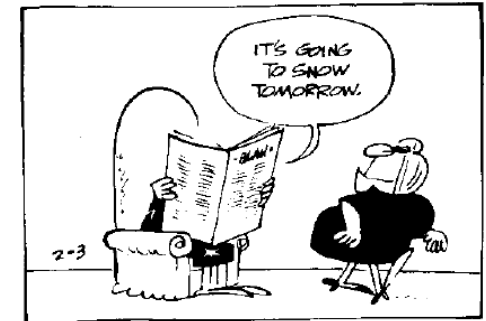
*"You can never solve a problem on the level on which it was created." Albert Einstein*

2. Most applied methods used to satisfy the needs of a long-term technology forecast are modifications of Delphi surveys and scenarios building.
3. Knowledge extracted from the Theory of Inventive Problem Solving (TRIZ) and its posterior generations may contribute to the accuracy of the technology forecasting.
4. Complex forecasting methods do not necessarily provide a more accurate forecast than simple ones. Simple methods are less affected by data inaccuracy than complex ones and expenses to implement simple methods are lower.

# preliminary conclusions

...*Weather forecast for tonight: dark...*

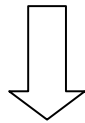
5. The choice of a forecast method mostly depends on data. Formal methods are reproducible, however they do not work well with qualitative parameters.
6. The efficiency of the existing forecasting methods depends upon a forecasting horizon.
7. The efficiency of forecasting depends not only on the methods applied but also the management of the whole forecasting process.



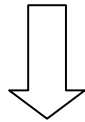


# 3. problem set about technology forecast

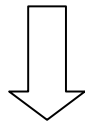
**Forecast models development stage**



**Forecast models design stage**



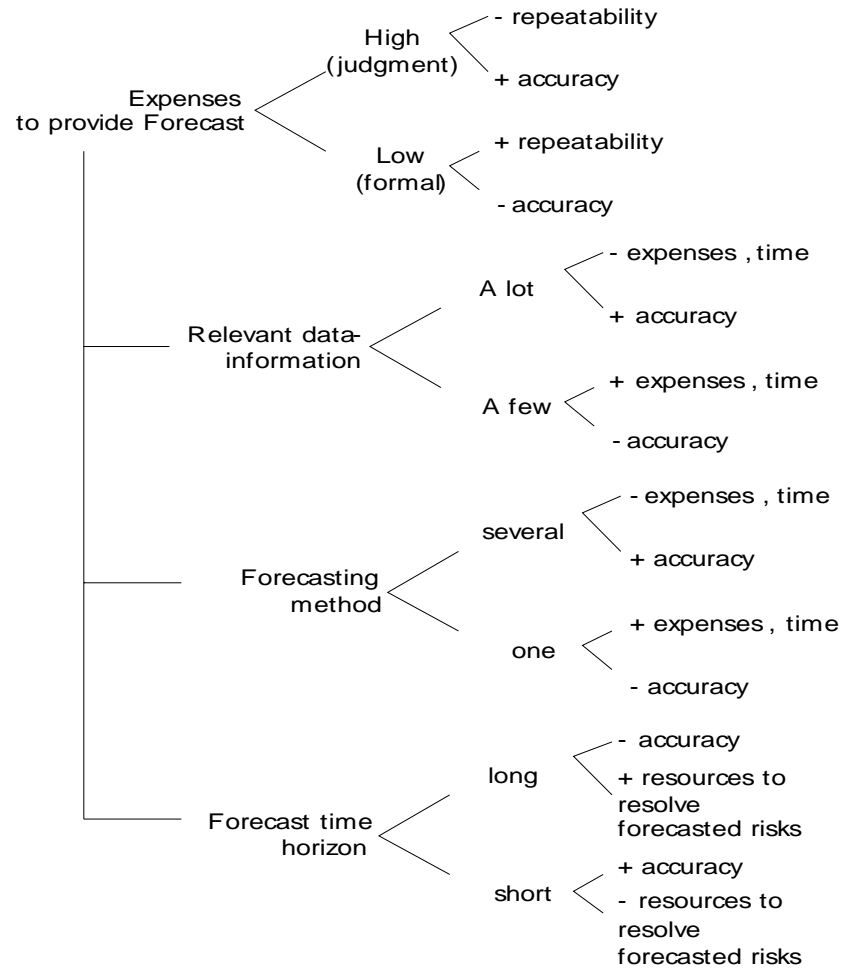
**Application of forecast models stage (use the results)**



**Retirement of forecast stage**

*Forecast problem has to be formulated precisely, in order to use forecast results for decision making; BUT Forecast problem has to be formulated approximately, in order to avoid predilection and influence of dominant concepts.*

# 3. fragment of problem set



# 4. stationary Fuel Cell technology

*'... the answers we find, and the understanding we develop, are shaped by the questions we ask...'* Gene Bellinger

## Forecast questions:

1. What will be the Evolution of the market penetration for Stationary Fuel Cell (SFC)?
2. What will be the evolution of the SFC comparing to competitive technologies?
3. What is the best path towards the ideal system of SFC?

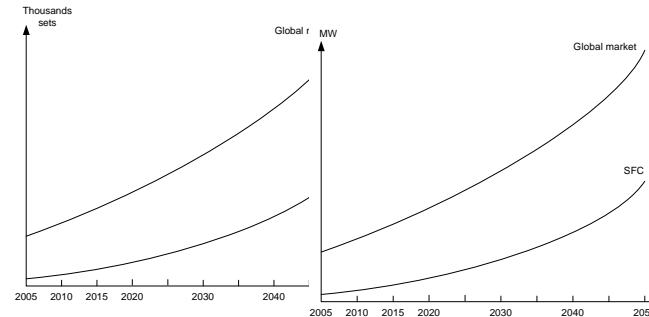


Fig 1. Penetration curves of SFC in Europe:  
a) in terms of number of installed sets ; b) in terms of global capacity, MW

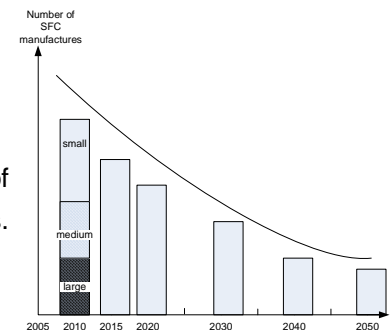
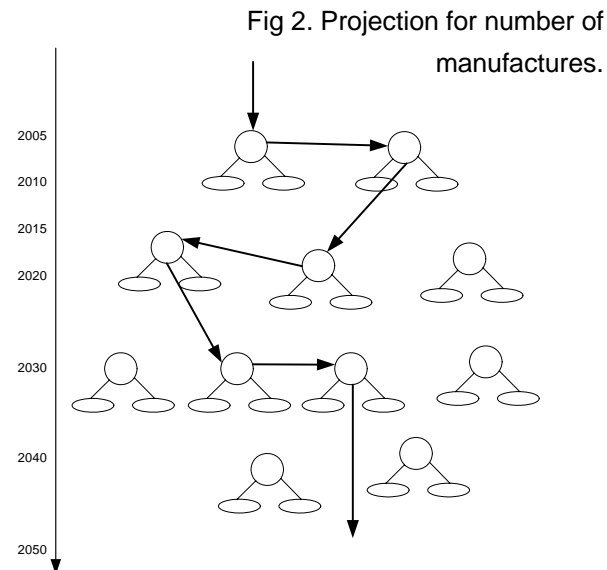
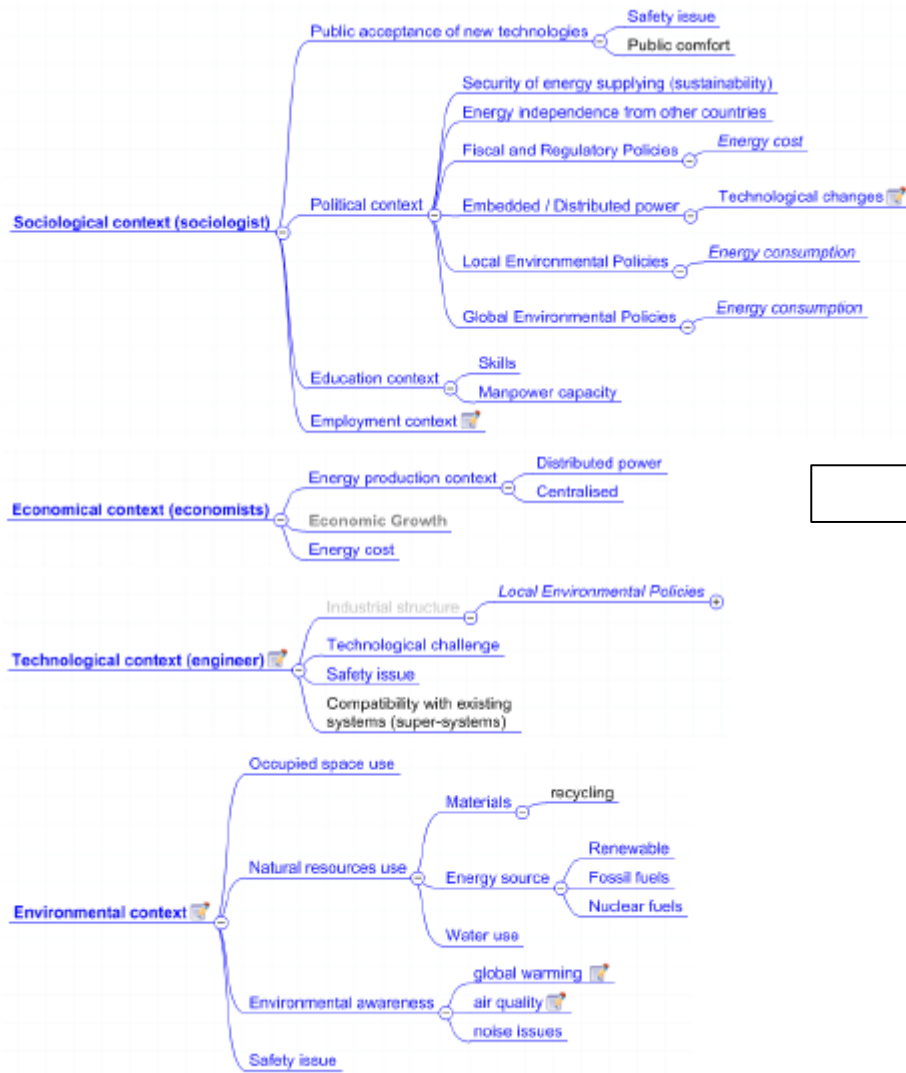


Fig. 3. Critical path through the network of contradictions.

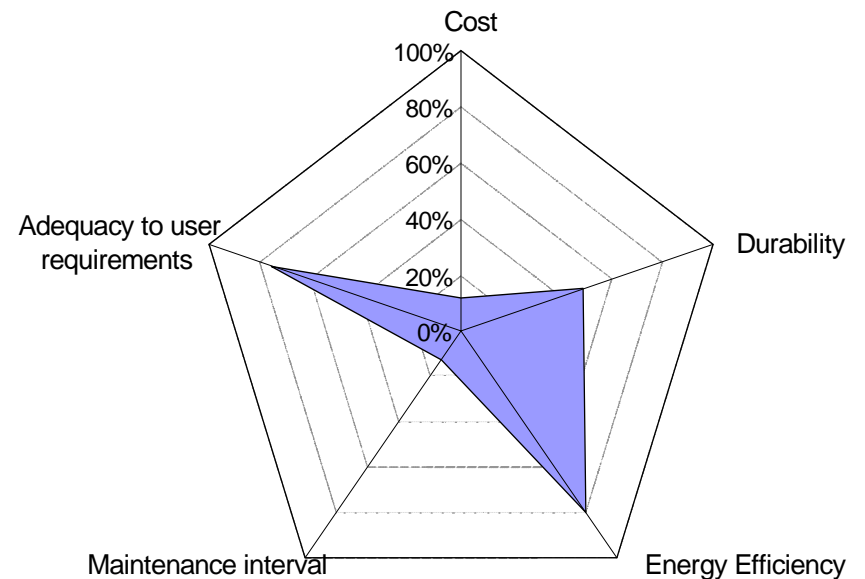
# stationary Fuel Cell technology

context definitions:



definition of critical-to-market features (according to the ENV modeling rules):

**(0.5kW < SMALL < 36kW) SFC: PEMFC**

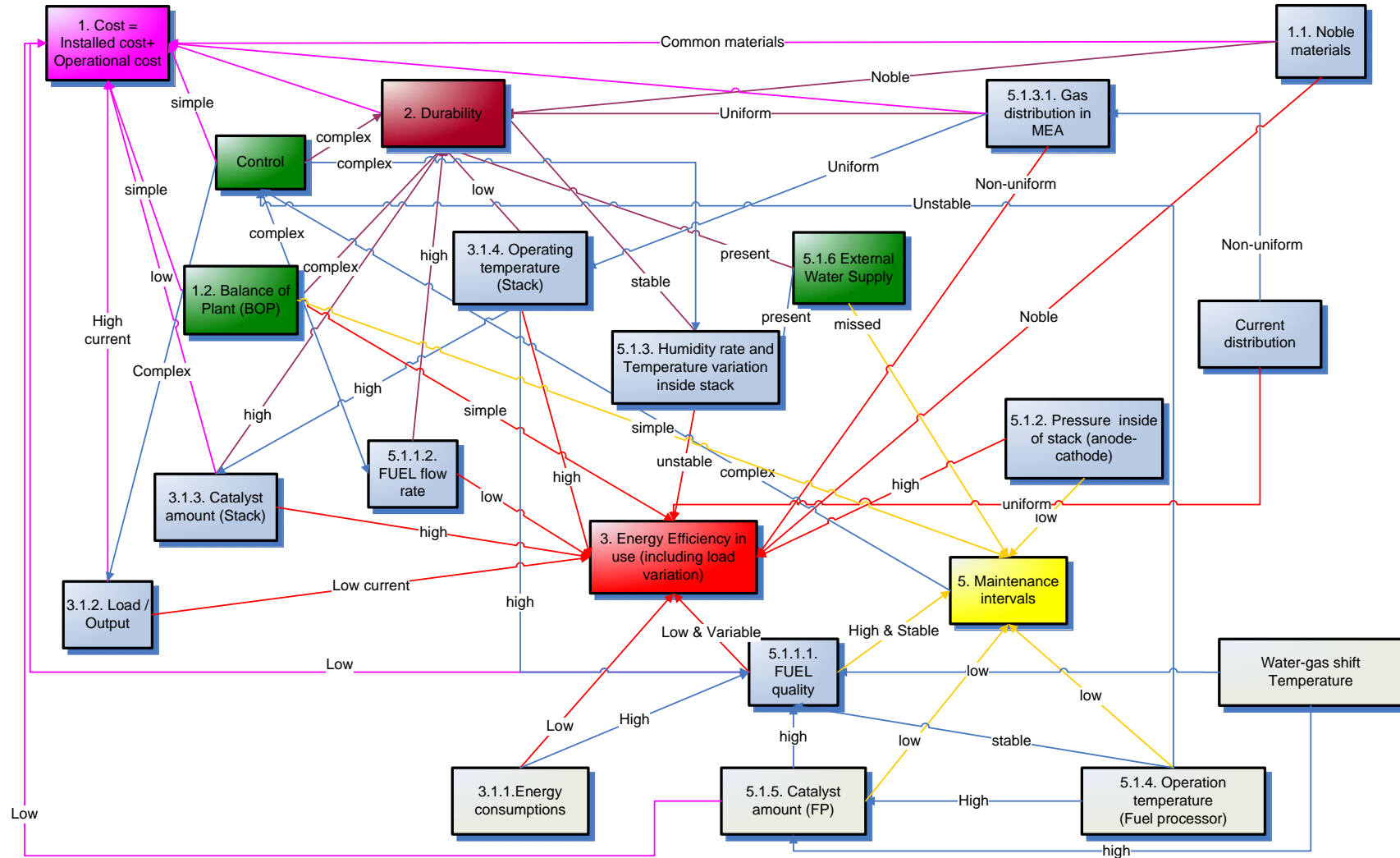


*Analysis of critical-to-market features for Proton Exchange Membrane Fuel Cell (PEMFC).*

# stationary Fuel Cell technology

## Map of Problems for 0.5kW < small SFC < 36kW (PEMFC)

Technology Forecast | Problems of Forecast



## 5. perspectives

*'...Prediction based on opinion did no better than selecting arbitrarily from the listed opinions...'*

1. To organize the collected set of problems in the shape of the Map of Problems.
2. To improve transparency of the methodology applied to stationary Fuel Cell.
3. To test the proposed concept solutions (ideas) about problems of forecast in practical projects.
4. Regularly update the Map of Problems concerning the technology forecast.
5. To position the technology forecast in a multi-dimensional forecast environment.

# The End

*...Intellectuals solve problems, geniuses prevent them...  
attributed to Albert Einstein*

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