

INSA STRASBOURG GRADUATE SCHOOL OF SCIENCE AND TECHNOLOGY
ARCHITECTS + ENGINEERS

*LGECO* 

TECHNOLOGICAL FORECASTING AND ASSESSMENT OF BARRIERS FOR EMERGING TECHNOLOGIES

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- Logistic S-curve & Limitation of Resources
- Problem mapping & Network of contradictions
- Contradictions & Assessment of technology barriers

### Limitation of resources and logistic S-curve





Image source: www.cbsnews.com

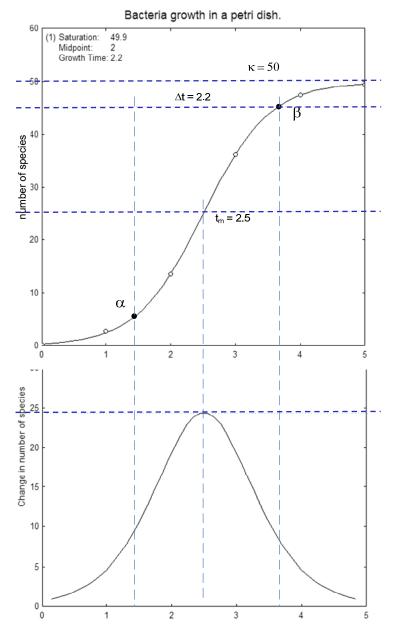
$$N(t) = \frac{\kappa}{1 + e^{-\alpha t - \beta}}$$

a – growth rate parameter, time required for "trajectory" to grow from 10% to 90% of limit  $\kappa$ 

### characteristic duration ( $\Delta t$ );

 $\beta$  – parameter specifies the time (t<sub>m</sub>) when the curve reaches  $0.5\kappa$  midpoint of the growth trajectory;

 $\kappa$  – is the asymptotic **limit of growth**.

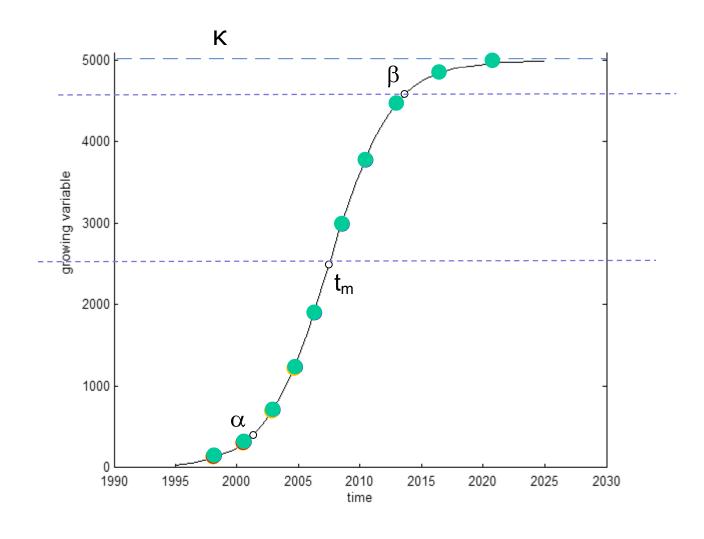


## TECHNOLOGICAL FORECASTING AND ASSESSMENT OF BARRIERS...

### Limitation of resources and logistic S-curve



[data covering and expected uncertainties on S-curve forecasts]



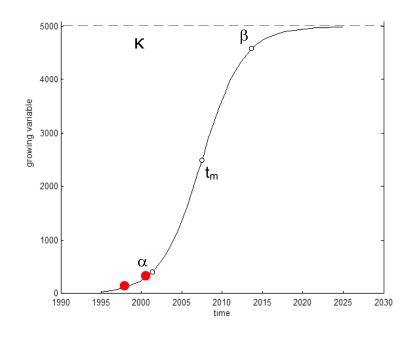
## TECHNOLOGICAL FORECASTING AND ASSESSMENT OF BARRIERS...

### Emerging technologies and logistic S-curve



[what is available data for emerging technologies?]

Naïve methods:  $\begin{array}{c|c} Y_{t-d},...,Y_{t-2},Y_{t-1},Y_t & \rightarrow & Y_{t+h} \\ \hline \\ Causal methods: & X_{t-d},...,X_{t-2},X_{t-1},X_t & \rightarrow & X_{t+h} \\ \hline \\ & \downarrow b & \downarrow b_h \\ \hline \\ & Y_{t-d},...,Y_{t-2},Y_{t-1},Y_t & Y_{t+h} \\ \hline \end{array}$ 



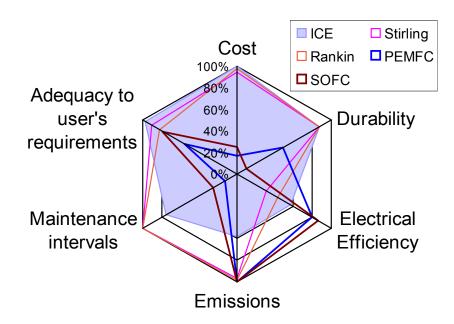
## What can be an "X" to forecast emerging technology?

 Knowledge about Technology barriers and resource limitations

### Assessment of technology barriers



[emerging technology: fuel cells]



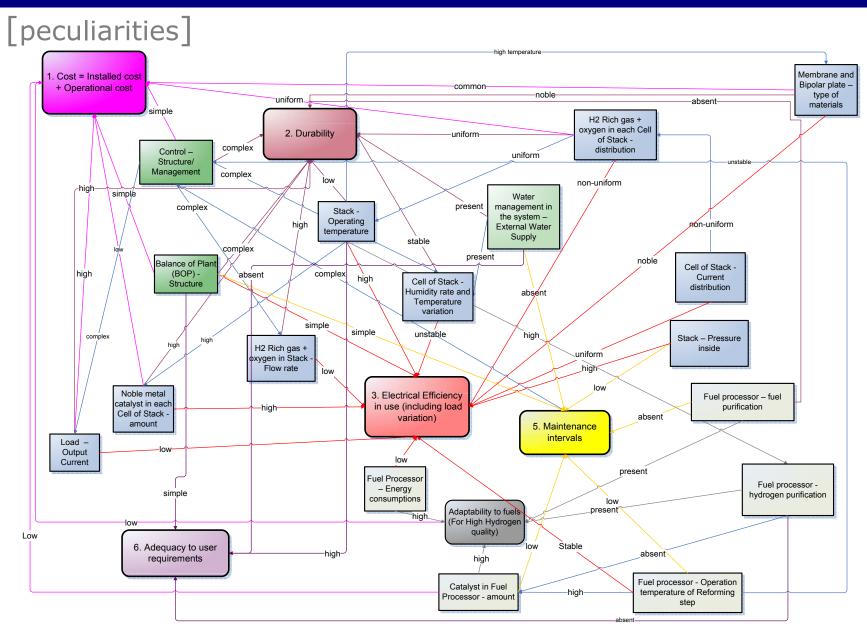
Larger gap between desired value of feature and actual one indicates more problems to be solved on the way to commercialize an emerging technology.

			PEMFC			SOFC	
		actual	market target	performed	actual	market target	performea
1.	Cost:	17%	100%		25%	100%	
1.1.	Installed Cost NG, EUR/kW	15000	4000		10000	4000	
				27%			409
	Importance: High		_	2. 70		_	
1.2	Operational cost, EUR/kWh	0.3	0.02		0.2	0.02	
				7%			109
	Importance: High						
2.	Durability:	49%	100%		10%	100%	
2.1	Durability in operating	2	15		2	15	
	conditions, years			13%			13
	Importance: High		_			_	
2.2	Cycling ability, number of	125	125		10	125	
	stops per year			100%			8
	Importance: High					_	
2.3	Start up time, min	90	15		240	15	
				17%			6
	Importance: Moderat e			1770			O
3.	Energy Efficiency, %	85%	100%		93%	100%	
3.1	Electrical efficiency, %	28%	35%	80%	30%	35%	86
3.2	Thermal efficiency, %	59%	65%	91%	55%	50%	100
3.3	Ratio Electrical power /	0.51	0.04	9170	0.04	0.04	100
5.5	Thermal Power	0.51	0.04		0.04	0.04	
4.	Emissions	100%	100%		100%	100%	
	Importance: High	100%	10070		10070	10070	
4.1	Substances, ppm	40					
	, F F						
			CO < 56ppm	100%		CO < 56ppm	100
	Importance: High		NOx<34 ppm			NOx<34 ppm	
4.2	Noise, dB	0			0		
				100%	-		100
	Importance: High						
5.	Maintenance interval, h	1000	8000	13%	2000	8000	259
	Importance: Moderate			13/0			25,
6.	Adequacy to user	56%	100%		79%	100%	
0.	requirements,	30%	100 /6		19/0	100%	
6.1	min. temperature return, °C						
	Importance: High	50	60	83%	500	70	100
6.2	min. flow temperature, °C		_				
		=0	0.0	000/			400
- 2	Importance: Moderate	70	80	88%	900	90	100
6.3	size, m	1.5x0.85x1.7	0.5X0.5X1		0.55 x 0.55 x	0.5x0.5x1	
					1.60		
			_			_	
	Importance: Moderate	2.17	0.25	12%	0.48	0.25	52
6.4	weight, kg	500	70	14%	170	70	44
	Importance: Moderate			14%			41
	ппрогансе. точетие						
			46551			40.50	
	Average for technology:	39%	100%		40%	100%	

## BARRIERS OF ASSESSMENT TECHNOLOGICAL FORECASTING AND

### Networking the contradictions

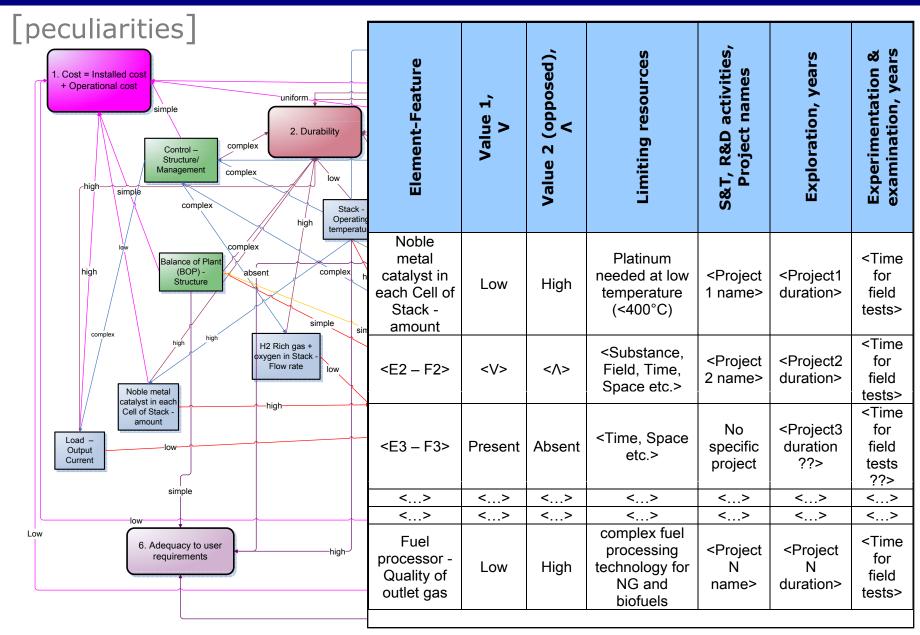




# TECHNOLOGICAL FORECASTING AND ASSESSMENT OF BARRIERS.

### Networking the contradictions

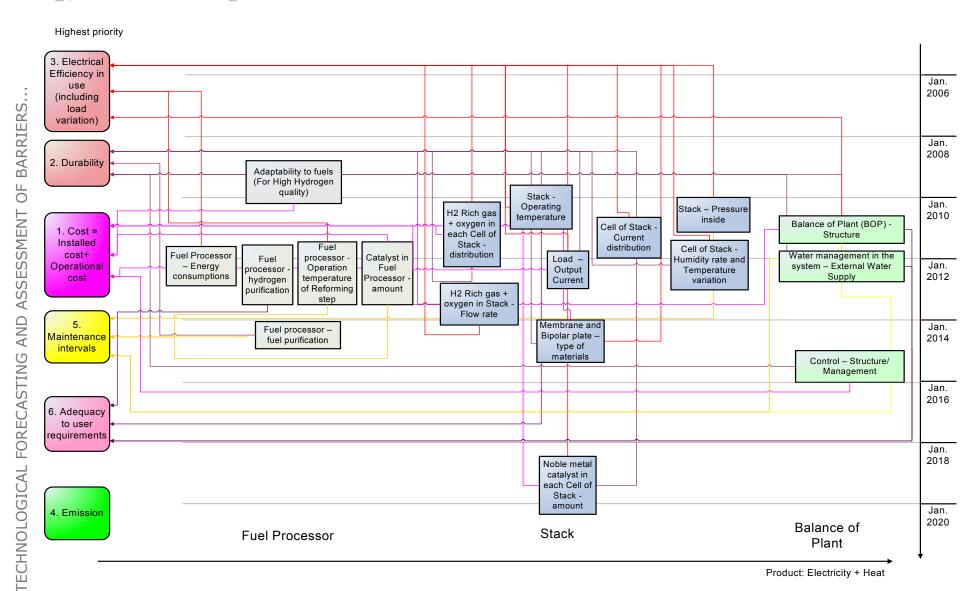




### Network of contradictions & time



### [peculiarities]



### **Results & Conclusions**



[Two projects performed in the period from Sep. 2004 to Dec. 2006]

Problem mapping and the assessment of scarce resources assists:

- in the assessment of technology barriers and opportunities in a bias-free way;
- in the accumulation of information about limited resources in a structured way;
- in the recognition of the alternative pathways independently from existing solutions.





The ultimate test of the forecaster is an accurate and reliable forecast not the elegant or easily applied method.

Theodor Modis, 2007

## Thank you for your attention :)

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### References

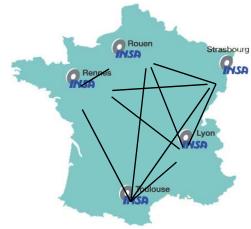


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### **INSA Strasbourg**



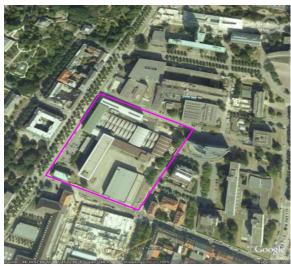
### GRADUATE SCHOOL OF SCIENCE AND TECHNOLOGY



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TECHNOLOGICAL FORECASTING AND ASSESSMENT OF BARRIERS...

students	created in	
INSA Lyon:	4 200	1957
INSA Rennes:	1 270	1967
INSA Rouen:	1 300	1985
INSA Toulouse:	1 830	1967
INSA Strasbourg: (previously ENSAIS, fo	2003	



http://www.insa-strasbourg.fr

- training of engineers and architects in 5 years
- scientific and technological research
- continuing education for engineers and technicians
- diffusion of scientific and technical culture

### **Research laboratory LGECO**



### DESIGN ENGINEERING LABORATORY

### Research directions

- Modelling and understanding design.
- Tools for improving design process.
- · Specific knowledge and functions for design.

### **Application areas**

- Manufacturing systems: material, process and production systems.
- Environment: renewable energies, hydraulics (dam, dikes).
- Health: biomechanics (prosthesis joining bones), robotics.



http://www.insa-strasbourg.fr/fr/lgeco/

### Domain of research

- Engineering
- Knowledge engineering and computer science
- Innovation management

### Technological forecasting process



[working model]

