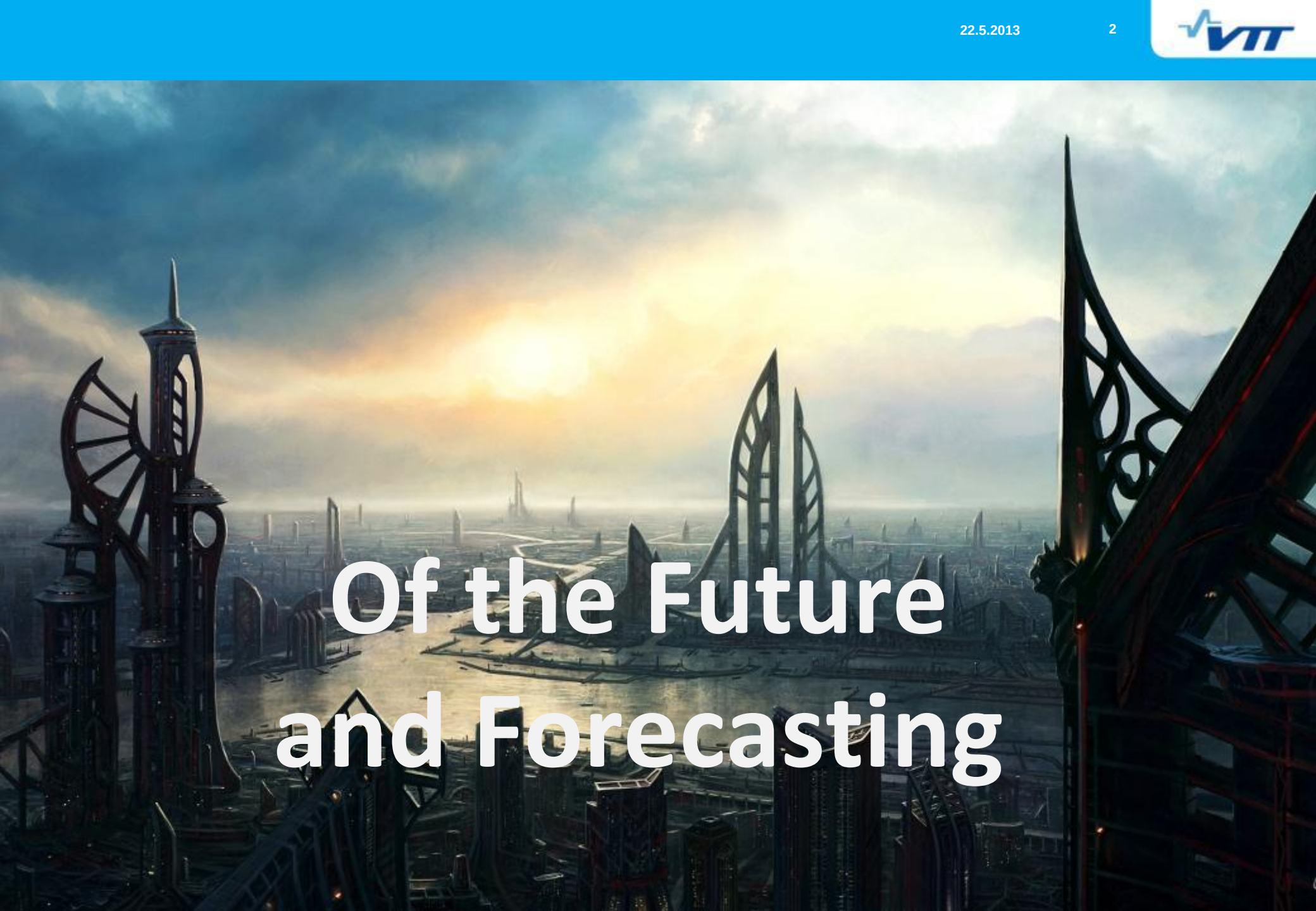


Integrating transport energy supply with the energy system of the future

Juhani Laurikko, VTT

**MOBILITY: TECHNOLOGY PRIORITIES AND
STRATEGIC URBAN PLANNING**

IEA-EGRD Workshop
22-24 May 2013, Finland

The background of the slide is a cinematic image of a futuristic city. The architecture is highly advanced, with tall, dark, spire-like structures and intricate mechanical details. The city is situated along a body of water, and the scene is illuminated by a bright, low sun, creating a dramatic sunset or sunrise effect with long shadows and a hazy atmosphere. The overall color palette is dominated by blues, greys, and the warm oranges and yellows of the sun.

Of the Future and Forecasting

What is the Future?

- ***The Future is***, according to the linear concept of time, the ***portion of the timeline that has not yet happened***
- The portion that has already taken place is called ***the Past***
- The phase that is on-going at the moment is called ***the Present***



Why Do We Have Interest in the Future?

- Our interest in the Future is often linked with:
 - ***Desire to plan and prepare for the changes*** in the operating environment that may threaten your business or activity and its continuum
 - ***Find new, arising possibilities*** that may support growth or development of new business.



How Can We Forecast the Future?

- ***Forecasting*** is presenting an estimate of the Future, based on **interpretation of the omens that convey future trends.**
- ***We cannot predict the future***, but is possible to explore it with a systematic method, and to present **alternative images of the future called Visions.**
- ***Visions arise from*** the construction of time-phased and logically progressive **development paths called Scenarios**

In the Past...



...Now!

Microsoft Excel - Book1

File Edit Format Tools Data Window Help

Worksheet: Formula Bar: =A1+B1

Sheet1

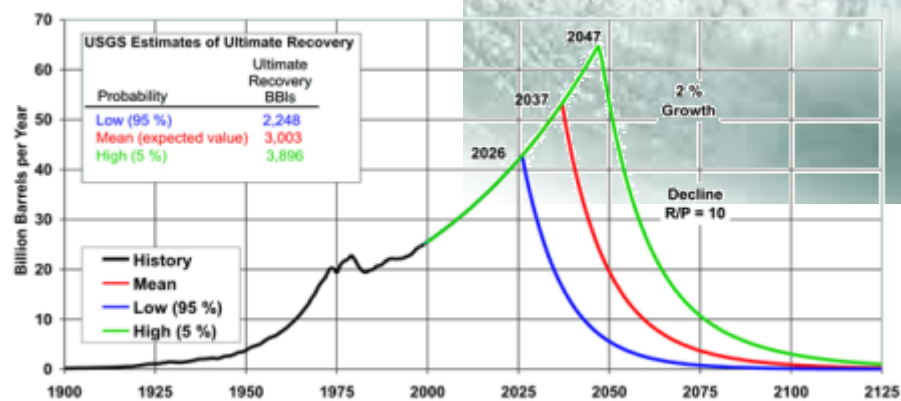
Networks: Network Inventory

updated: 4-05-2013

Code	Date	Open	High	Low	Low	Volume	Price	Close	Old	Ask	Name
1	3/03/2005	1.94	1.94	1.93	1.93	121118	1.93	1.94	0.15	0.15	0.15
2	3/03/2005	0.29	0.29	0.19	0.19	13506	0.19	0.19	0.19	0.19	0.19
3	3/03/2005	0	0	0	0	0	0	0	0	0	0
4	3/03/2005	0.288	0.288	0.288	0.288	102439	0.288	0.288	0.288	0.288	0.288
5	3/03/2005	0.55	0.55	0.55	0.55	404427	0.54	0.56	0.57	0.57	0.57
6	3/03/2005	0.84	0.84	0.827	0.827	6293863	0.829	0.827	0.828	0.828	0.828
7	3/03/2005	0.175	0.175	0.175	0.175	10906	0.17	0.17	0.17	0.17	0.17
8	3/03/2005	0	0	0	0	0	0	0	0	0	0
9	3/03/2005	1.34	1.34	1.34	1.34	1299576	1.34	1.34	1.34	1.34	1.34
10	3/03/2005	6.6	6.6	6.54	6.54	46378	6.51	6.58	6.58	6.58	6.58
11	3/03/2005	1.81	1.81	1.81	1.81	630703	1.81	1.81	1.81	1.81	1.81
12	3/03/2005	0.12	0.12	0.113	0.113	10841392	0.11	0.12	0.12	0.12	0.12
13	3/03/2005	0.155	0.155	0.155	0.155	5306	0.155	0.155	0.155	0.155	0.155
14	3/03/2005	0	0	0	0	0	0	0	0	0	0
15	3/03/2005	0	0	0	0	0	0	0	0	0	0
16	3/03/2005	0	0	0	0	0	0	0	0	0	0
17	3/03/2005	0	0	0	0	0	0	0	0	0	0
18	3/03/2005	0	0	0	0	0	0	0	0	0	0
19	3/03/2005	0	0	0	0	0	0	0	0	0	0
20	3/03/2005	0	0	0	0	0	0	0	0	0	0
21	3/03/2005	1.37	1.37	1.36	1.36	34522	1.37	1.36	1.36	1.36	1.36
22	3/03/2005	0.384	0.384	0.384	0.384	6298	0.38	0.388	0.388	0.388	0.388
23	3/03/2005	5.47	5.47	5.44	5.44	338104	5.47	5.5	5.5	5.5	5.5
24	3/03/2005	0	0	0	0	0	0	0	0	0	0
25	3/03/2005	0	0	0	0	0	0	0	0	0	0
26	3/03/2005	0	0	0	0	0	0	0	0	0	0
27	3/03/2005	0	0	0	0	0	0	0	0	0	0
28	3/03/2005	0	0	0	0	0	0	0	0	0	0
29	3/03/2005	0	0	0	0	0	0	0	0	0	0
30	3/03/2005	0	0	0	0	0	0	0	0	0	0
31	3/03/2005	0	0	0	0	0	0	0	0	0	0
32	3/03/2005	0	0	0	0	0	0	0	0	0	0
33	3/03/2005	0	0	0	0	0	0	0	0	0	0
34	3/03/2005	0	0	0	0	0	0	0	0	0	0
35	3/03/2005	0	0	0	0	0	0	0	0	0	0
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37	3/03/2005	0	0	0	0	0	0	0	0	0	0
38	3/03/2005	0	0	0	0	0	0	0	0	0	0
39	3/03/2005	0	0	0	0	0	0	0	0	0	0
40	3/03/2005	0	0	0	0	0	0	0	0	0	0
41	3/03/2005	0	0	0	0	0	0	0	0	0	0
42	3/03/2005	0	0	0	0	0	0	0	0	0	0
43	3/03/2005	0	0	0	0	0	0	0	0	0	0
44	3/03/2005	0	0	0	0	0	0	0	0	0	0
45	3/03/2005	0	0	0	0	0	0	0	0	0	0
46	3/03/2005	0	0	0	0	0	0	0	0	0	0
47	3/03/2005	0	0	0	0	0	0	0	0	0	0
48	3/03/2005	0	0	0	0	0	0	0	0	0	0
49	3/03/2005	0	0	0	0	0	0	0	0	0	0
50	3/03/2005	0	0	0	0	0	0	0	0	0	0
51	3/03/2005	0	0	0	0	0	0	0	0	0	0
52	3/03/2005	0	0	0	0	0	0	0	0	0	0
53	3/03/2005	0	0	0	0	0	0	0	0	0	0
54	3/03/2005	0	0	0	0	0	0	0	0	0	0
55	3/03/2005	0	0	0	0	0	0	0	0	0	0
56	3/03/2005	0	0	0	0	0	0	0	0	0	0
57	3/03/2005	0	0	0	0	0	0	0	0	0	0
58	3/03/2005	0	0	0	0	0	0	0	0	0	0
59	3/03/2005	0	0	0	0	0	0	0	0	0	0
60	3/03/2005	0	0	0	0	0	0	0	0	0	0
61	3/03/2005	0	0	0	0	0	0	0	0	0	0
62	3/03/2005	0	0	0	0	0	0	0	0	0	0
63	3/03/2005	0	0	0	0	0	0	0	0	0	0
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65	3/03/2005	0	0	0	0	0	0	0	0	0	0
66	3/03/2005	0	0	0	0	0	0	0	0	0	0
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72	3/03/2005	0	0	0	0	0	0	0	0	0	0
73	3/03/2005	0	0	0	0	0	0	0	0	0	0
74	3/03/2005	0	0	0	0	0	0	0	0	0	0
75	3/03/2005	0	0	0	0	0	0	0	0	0	0
76	3/03/2005	0	0	0	0	0	0	0	0	0	0
77	3/03/2005	0	0	0	0	0	0	0	0	0	0
78	3/03/2005	0	0	0	0	0	0	0	0	0	0
79	3/03/2005	0	0	0	0	0	0	0	0	0	0
80	3/03/2005	0	0	0	0	0	0	0	0	0	0
81	3/03/2005	0	0	0	0	0	0	0	0	0	0
82	3/03/2005	0	0	0	0	0	0	0	0	0	0
83	3/03/2005	0	0	0	0	0	0	0	0	0	0
84	3/03/2005	0	0	0	0	0	0	0	0	0	0
85	3/03/2005	0	0	0	0	0	0	0	0	0	0
86	3/03/2005	0	0	0	0	0	0	0	0	0	0
87	3/03/2005	0	0	0	0	0	0	0	0	0	0
88	3/03/2005	0	0	0	0	0	0	0	0	0	0
89	3/03/2005	0	0	0	0	0	0	0	0	0	0
90	3/03/2005	0	0	0	0	0	0	0	0	0	0
91	3/03/2005	0	0	0	0	0	0	0	0	0	0
92	3/03/2005	0	0	0	0	0	0	0	0	0	0
93	3/03/2005	0	0	0	0	0	0	0	0	0	0
94	3/03/2005	0	0	0	0	0	0	0	0	0	0
95	3/03/2005	0	0	0	0	0	0	0	0	0	0
96	3/03/2005	0	0	0	0	0	0	0	0	0	0
97	3/03/2005	0	0	0	0	0	0	0	0	0	0
98	3/03/2005	0	0	0	0	0	0	0	0	0	0
99	3/03/2005	0	0	0	0	0	0	0	0	0	0
100	3/03/2005	0	0	0	0	0	0	0	0	0	0



Figure 2. Annual Production Scenarios with 2 Percent Growth Rates and Different Resource Levels (Decline R/P=10)



Source: Energy Information Administration

Note: U.S. volumes were added to the USGS foreign volumes to obtain world totals.



“Listen to the Visioneers”



FISITA World Automotive Congress 1998

“Many parts of the future are already here now, but in an embryonic state”

Carlos Ghosn

Chairman, CEO Renault-Nissan



On the Road in 2035

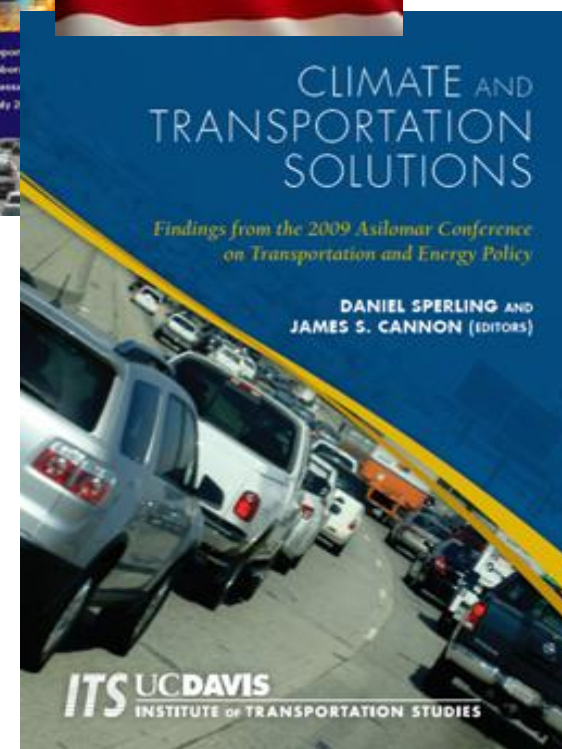
Reducing Transportation's
Petroleum Consumption
and GHG Emissions

Arun Banerjee
Kristian Bredt
Lynette Cheah
Christopher Evans
Tiffany Givens
John Heywood
Emmanuel Kassarolis
Matthew Kramer
Markus Weiss



Spinning Our Wheels

The Failures of the Auto Industry and Government in the
Quest for Lower Carbon Emissions, and What We Can Do
— Right Now — to Change Our Transportation System



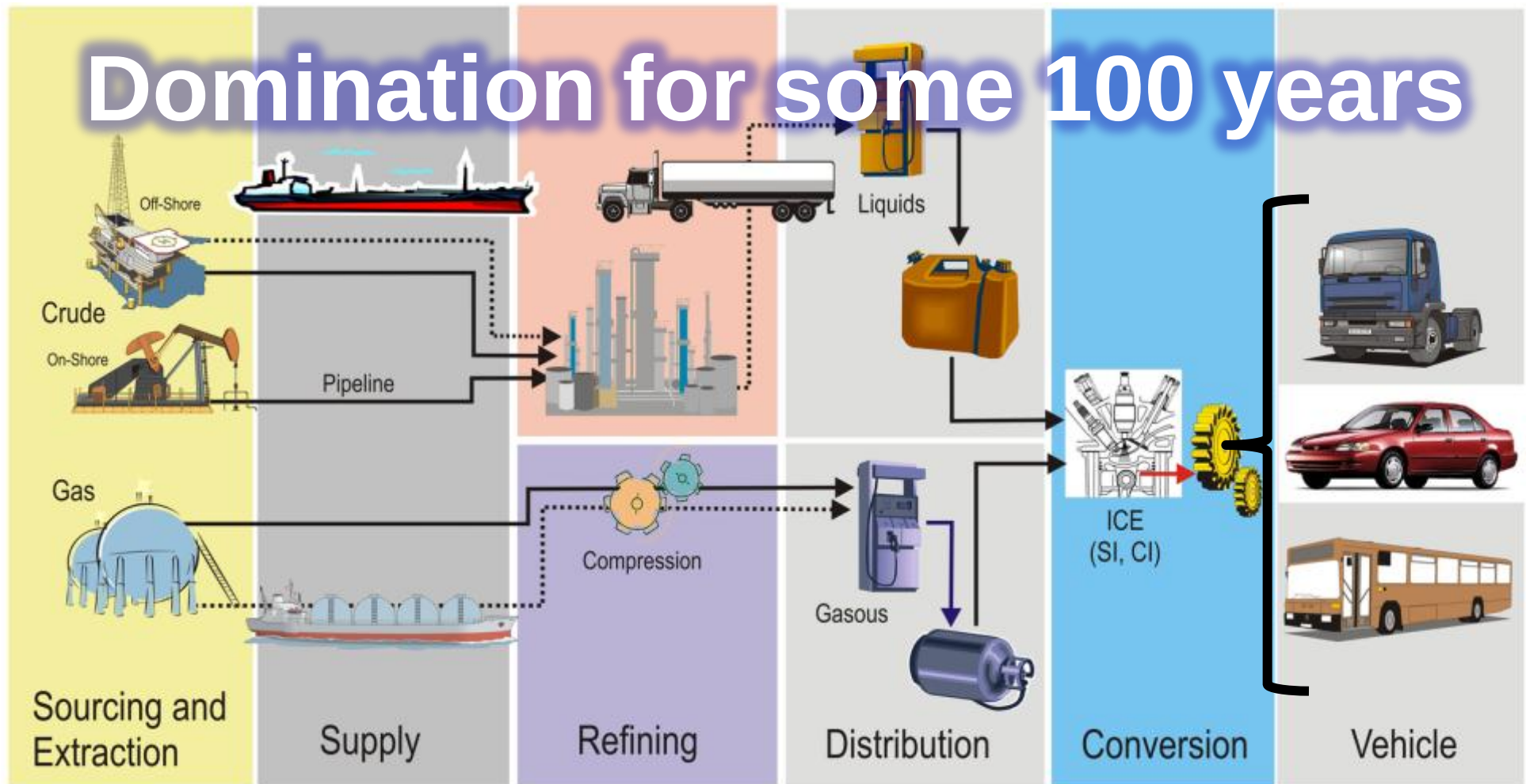
What Ultimately Determines the Future?

- There is ***not one, Deterministic Future*** that we need to predict!
- ***The Future is determined by the choices, decisions, and actions We take***
- It is not only necessary to prepare for the future, but ***we may also actively contribute*** in order to:
 - Avert the looming threats, or
 - **Create new opportunities**
- ***Interactively we can contribute to the development paths that will result in different futures!***

**What Makes
the Prediction Difficult...**



Traditional Pathway of Fossil Fuels in Transport Energy Use

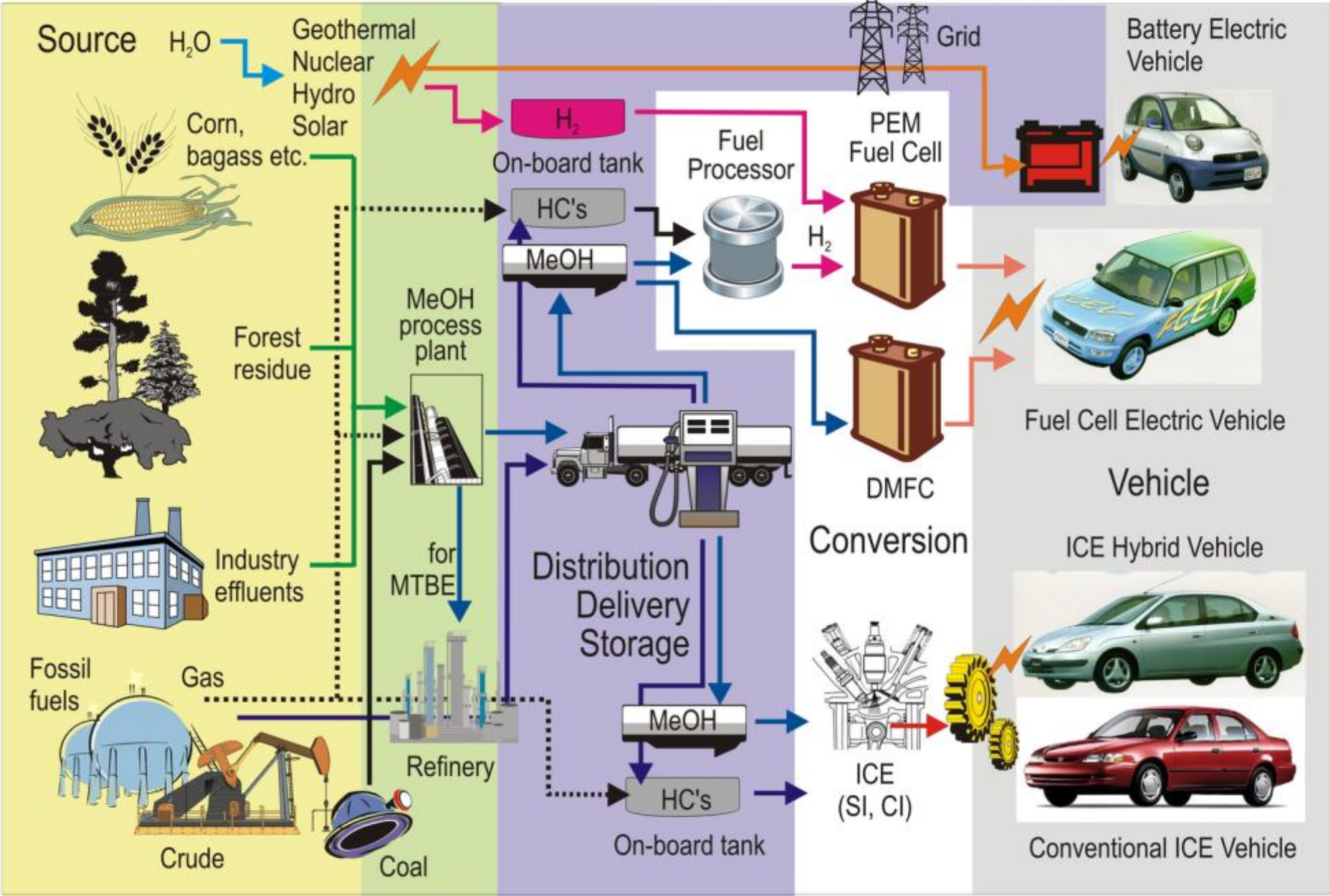


“The Race is On”

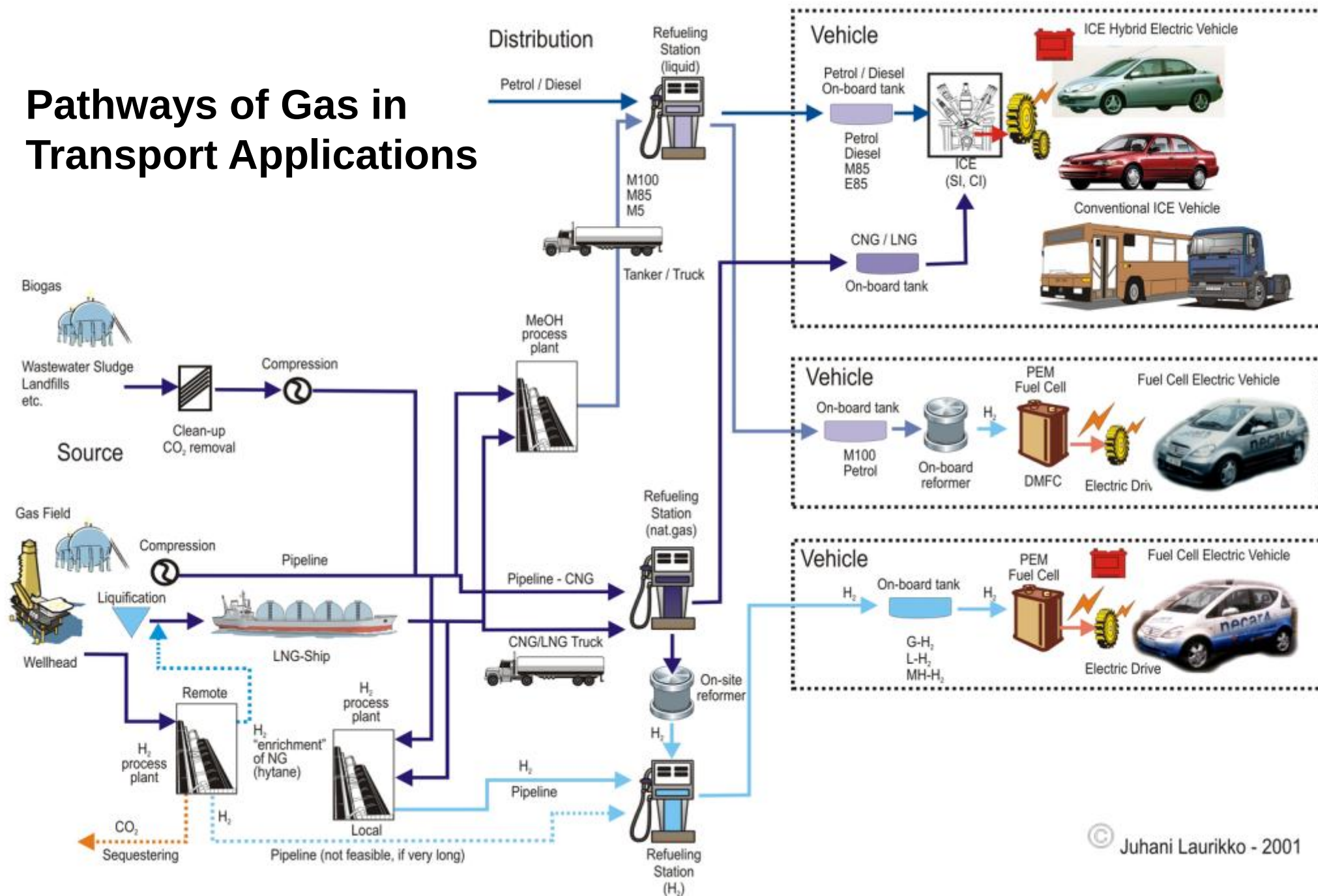


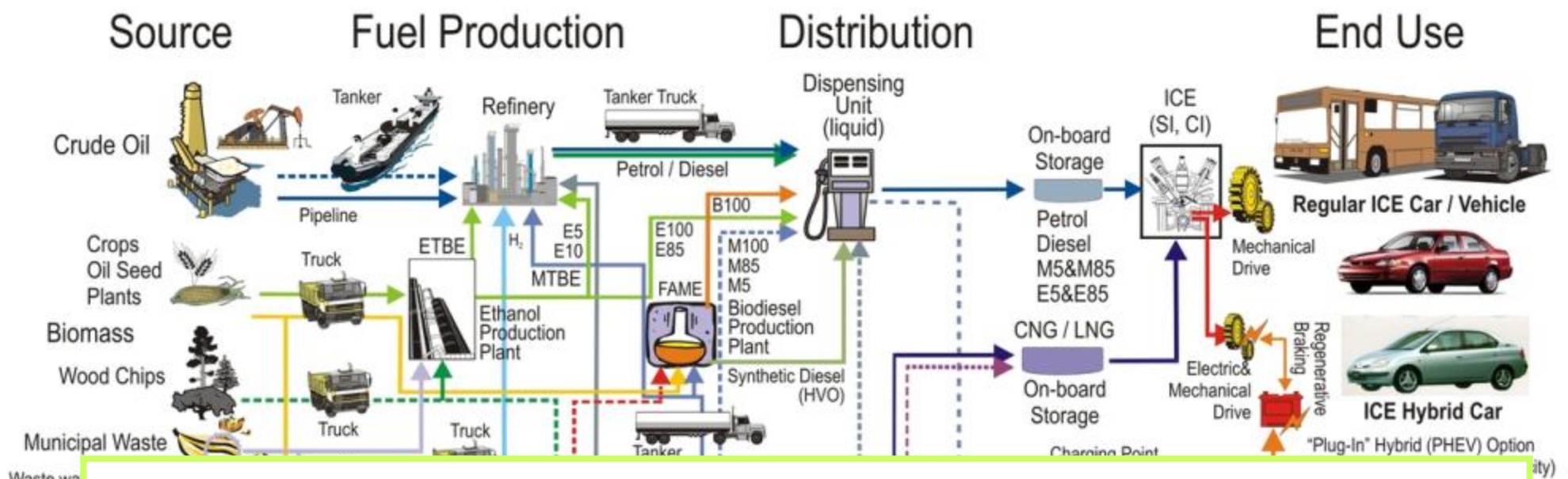
Pathways of Fuels & Energies in Transport Energy Use

(c) Laurikko - 2001

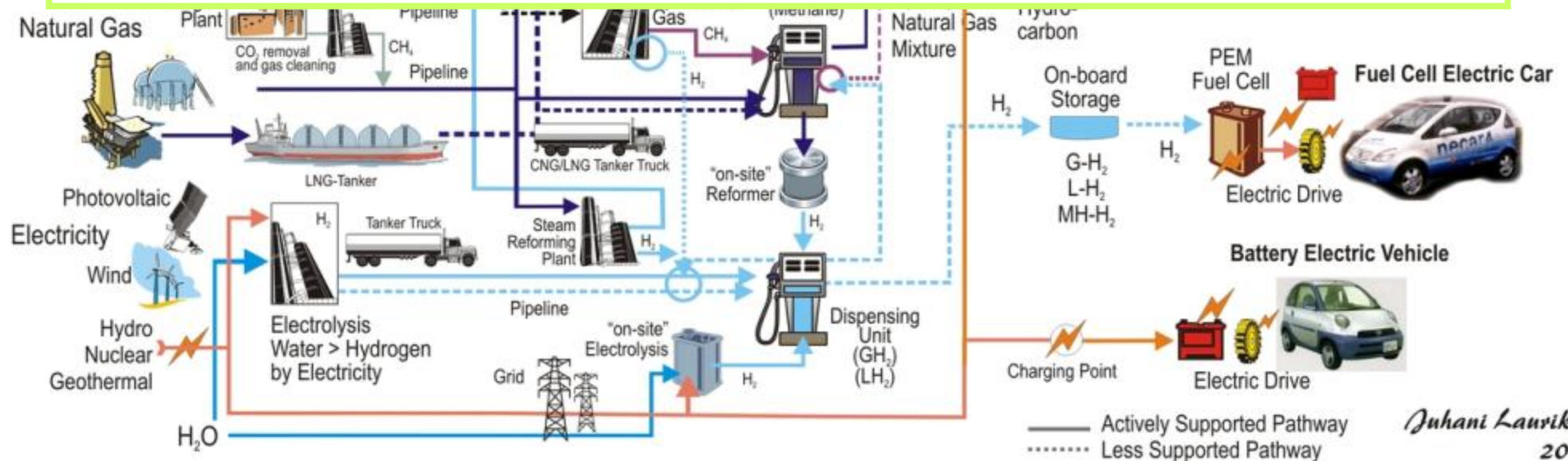


Pathways of Gas in Transport Applications



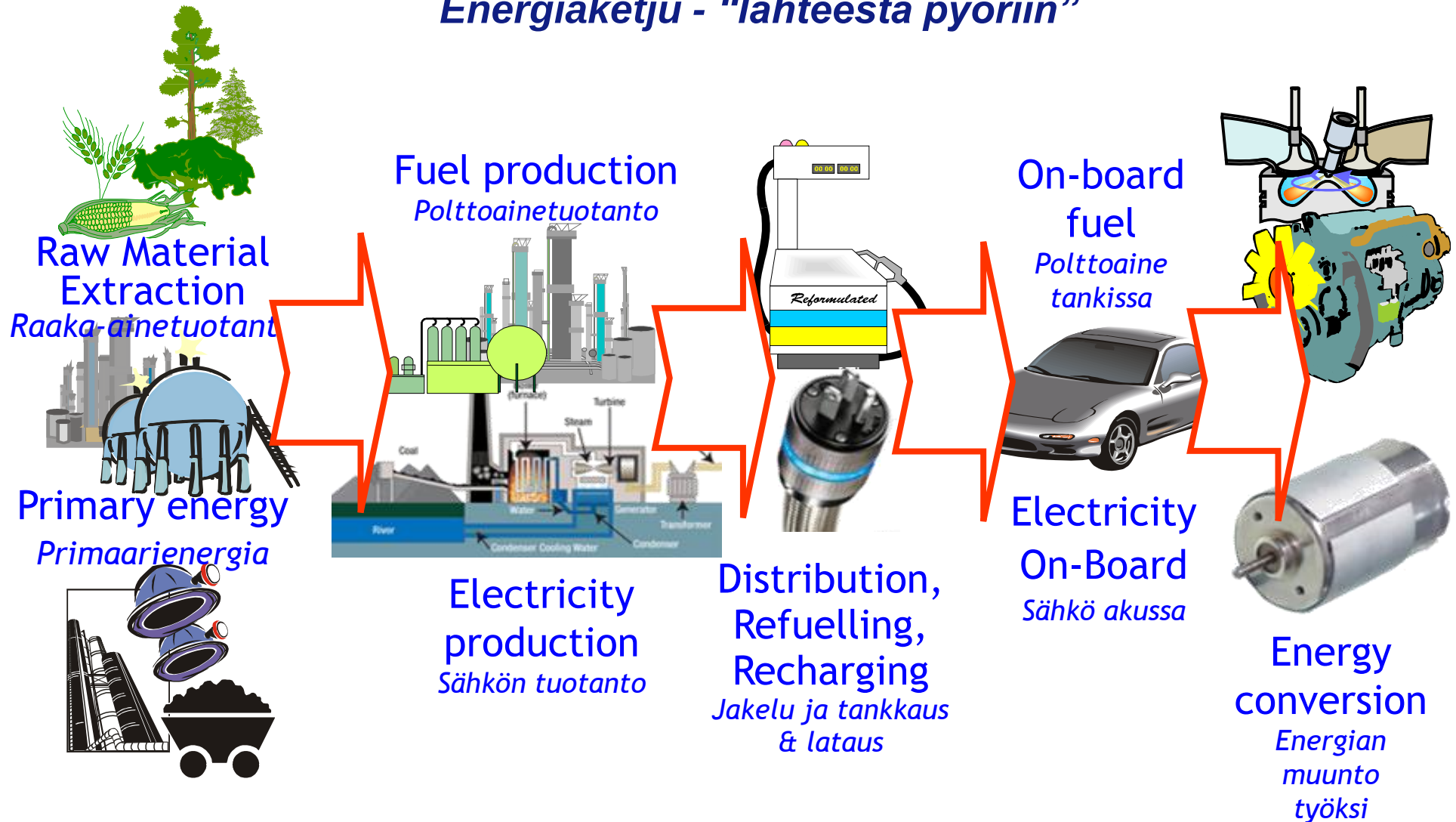


■ In pure technical terms the options are numerous, but not all are competitive!



Pathway analysis – Well-to-Wheels (WTW)

Energiaketju - “lähteestä pyöriin”



Critical Issues

Kriittiset tekijät

Abundance

Saatavuus

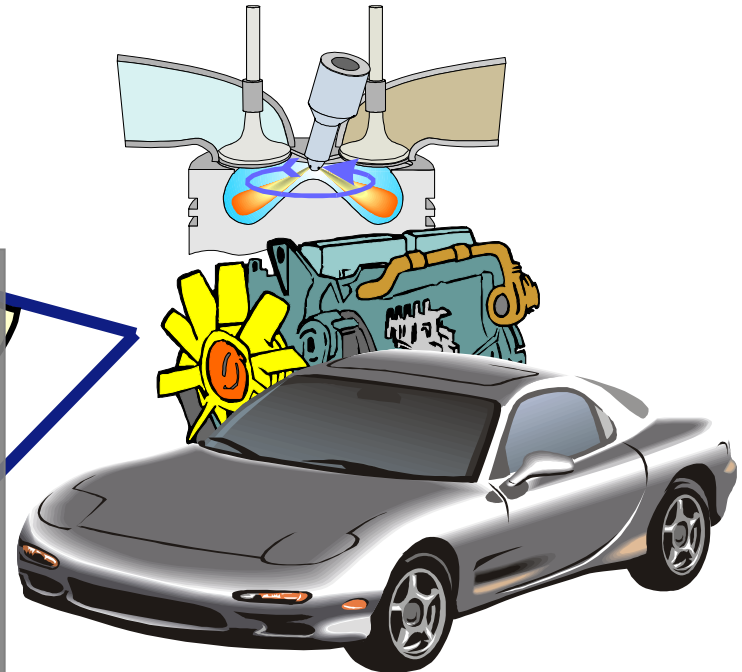
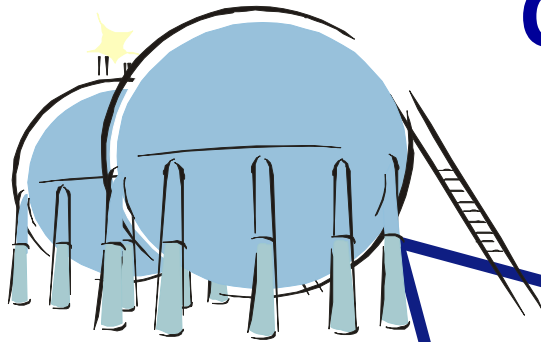
Any one
of these
can set
the limit!

Refuelling
infrastructure

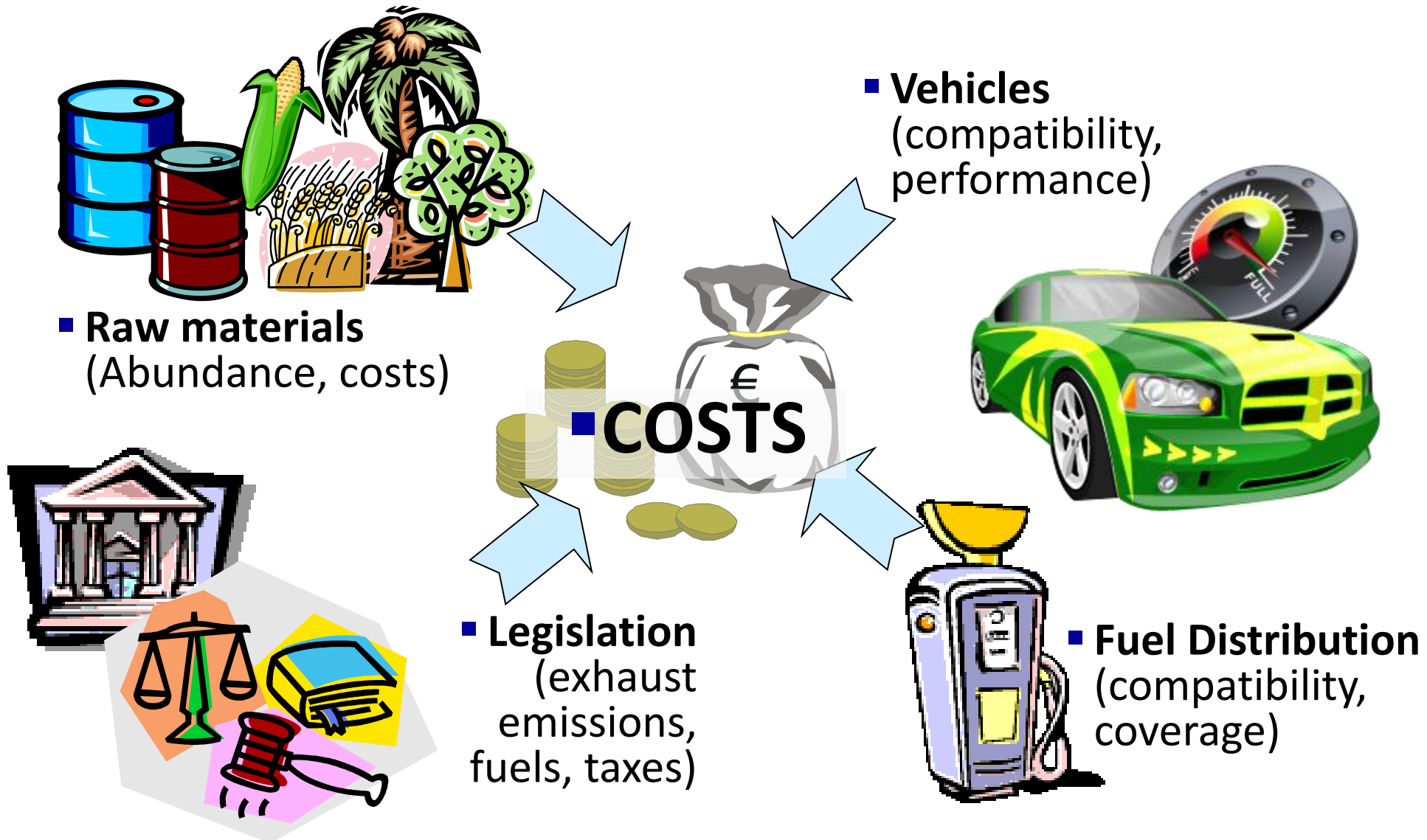
Polttoainejakelu

Compatible
engines&vehicles

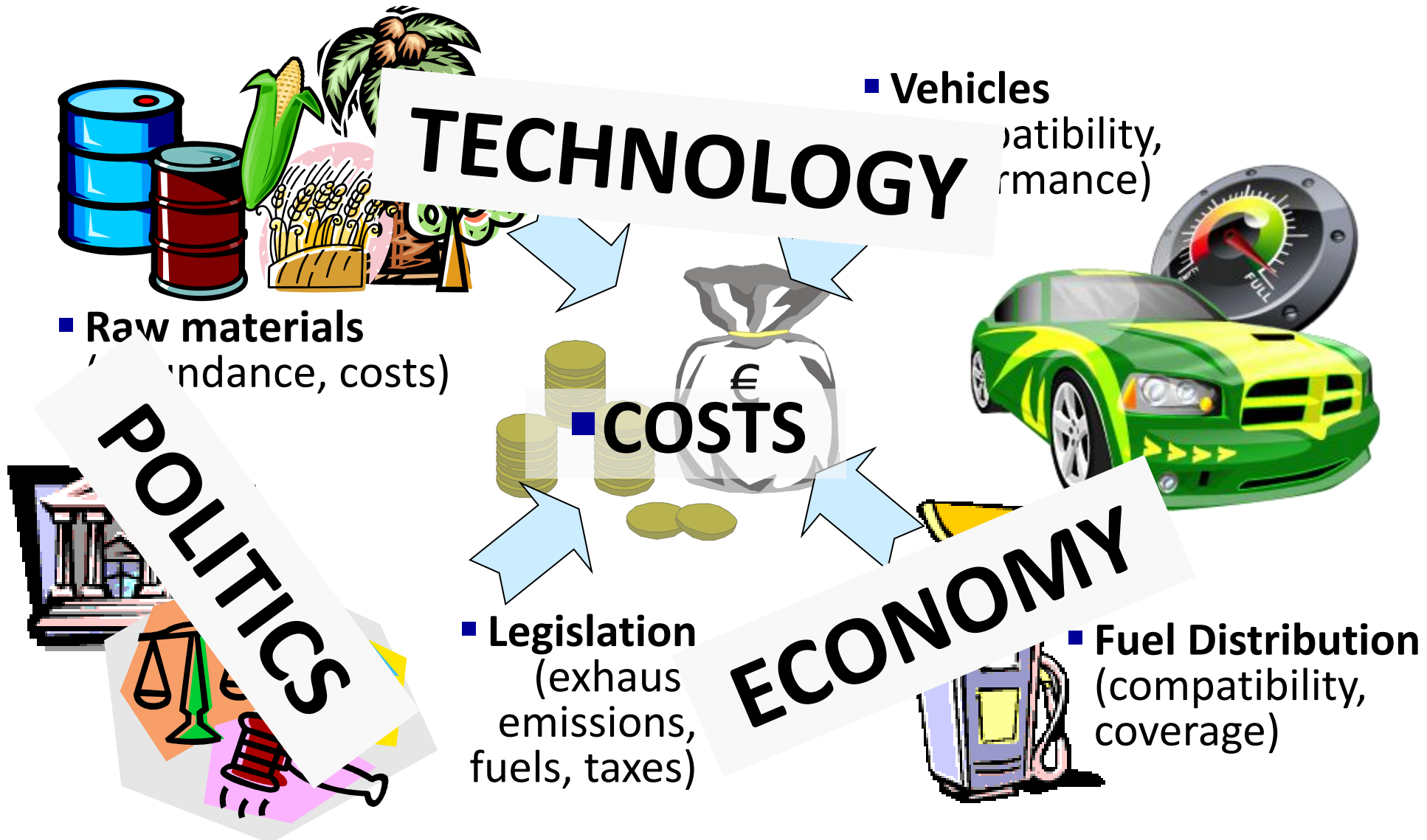
Yhteensopiva kalusto



KEY DRIVERS IN THE OPERATIONAL ENVIRONMENT



KEY DRIVERS IN THE OPERATIONAL ENVIRONMENT

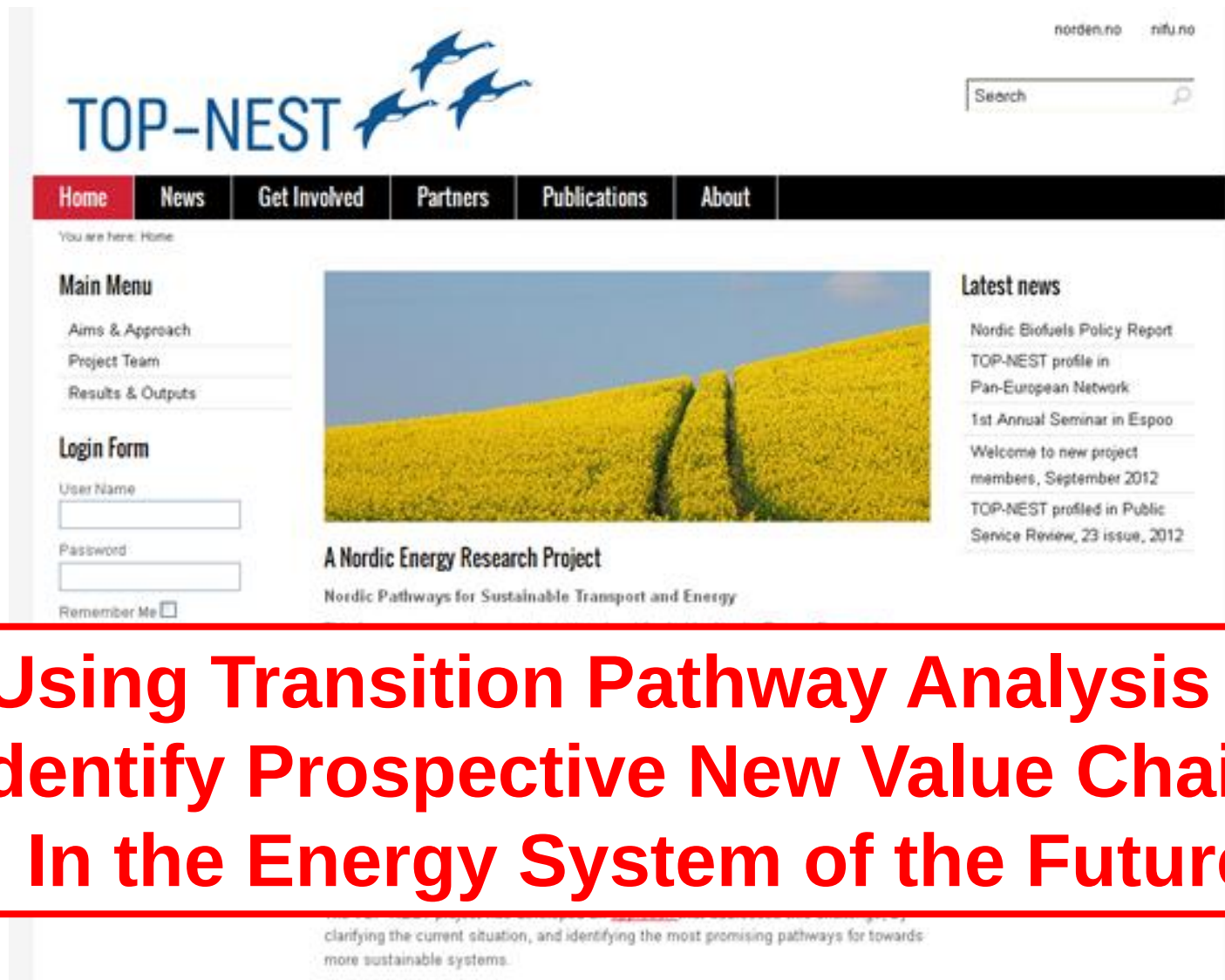




**What Helps us out in
Our Predictions...**

Use the Right Tools



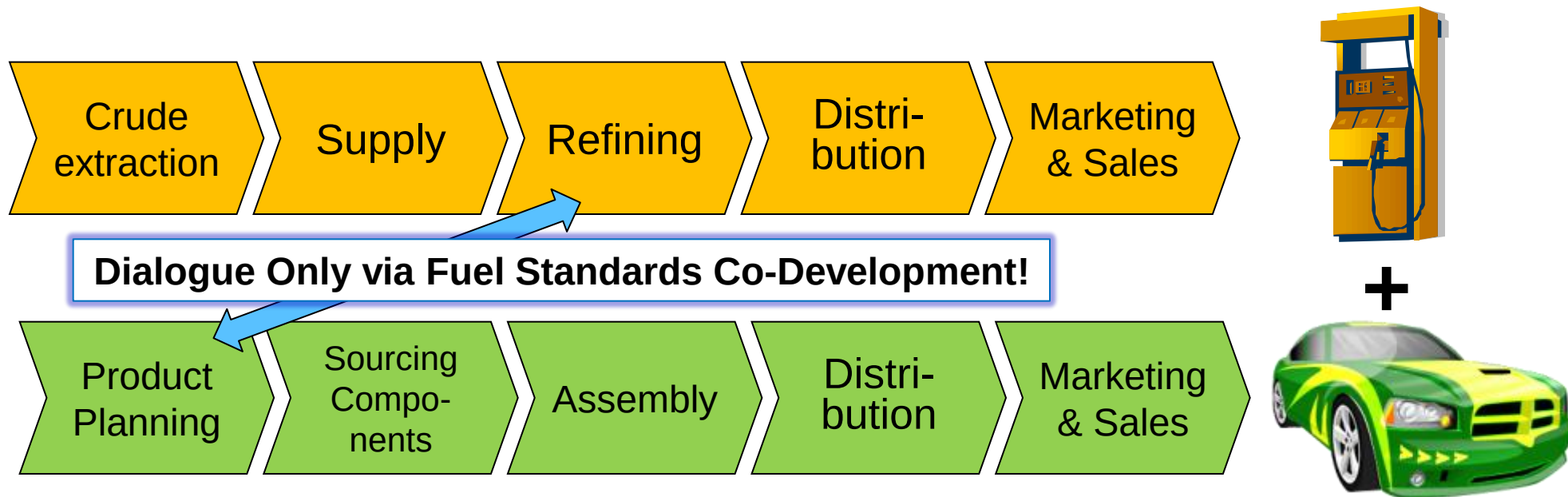


The screenshot shows the TOP-NEST website interface. At the top, the logo "TOP-NEST" is displayed with three stylized birds in flight to its right. To the right of the logo are the domain names "norden.no" and "nifu.no", and a search bar with the text "Search". Below the logo is a navigation menu with the following items: Home (highlighted in red), News, Get Involved, Partners, Publications, and About. Below the navigation menu, the text "You are here: Home" is visible. On the left side, there is a "Main Menu" section with links for "Aims & Approach", "Project Team", and "Results & Outputs". Below this is a "Login Form" with fields for "User Name" and "Password", and a "Remember Me" checkbox. In the center, there is a large image of a yellow field under a blue sky. Below the image, the text "A Nordic Energy Research Project" is displayed, followed by "Nordic Pathways for Sustainable Transport and Energy". On the right side, there is a "Latest news" section with a list of news items: "Nordic Biofuels Policy Report", "TOP-NEST profile in Pan-European Network", "1st Annual Seminar in Espoo", "Welcome to new project members, September 2012", and "TOP-NEST profiled in Public Service Review, 23 issue, 2012". At the bottom of the page, there is a red-bordered box containing the text "Using Transition Pathway Analysis to Identify Prospective New Value Chains In the Energy System of the Future". Below this box, there is a small text snippet: "clarifying the current situation, and identifying the most promising pathways for towards more sustainable systems."

Using Transition Pathway Analysis to Identify Prospective New Value Chains In the Energy System of the Future

clarifying the current situation, and identifying the most promising pathways for towards more sustainable systems.

Present-day Value Chains of Cars & Fuels



**Well-Established and Long-Term Co-Existence,
but No Cross-Ownership!**

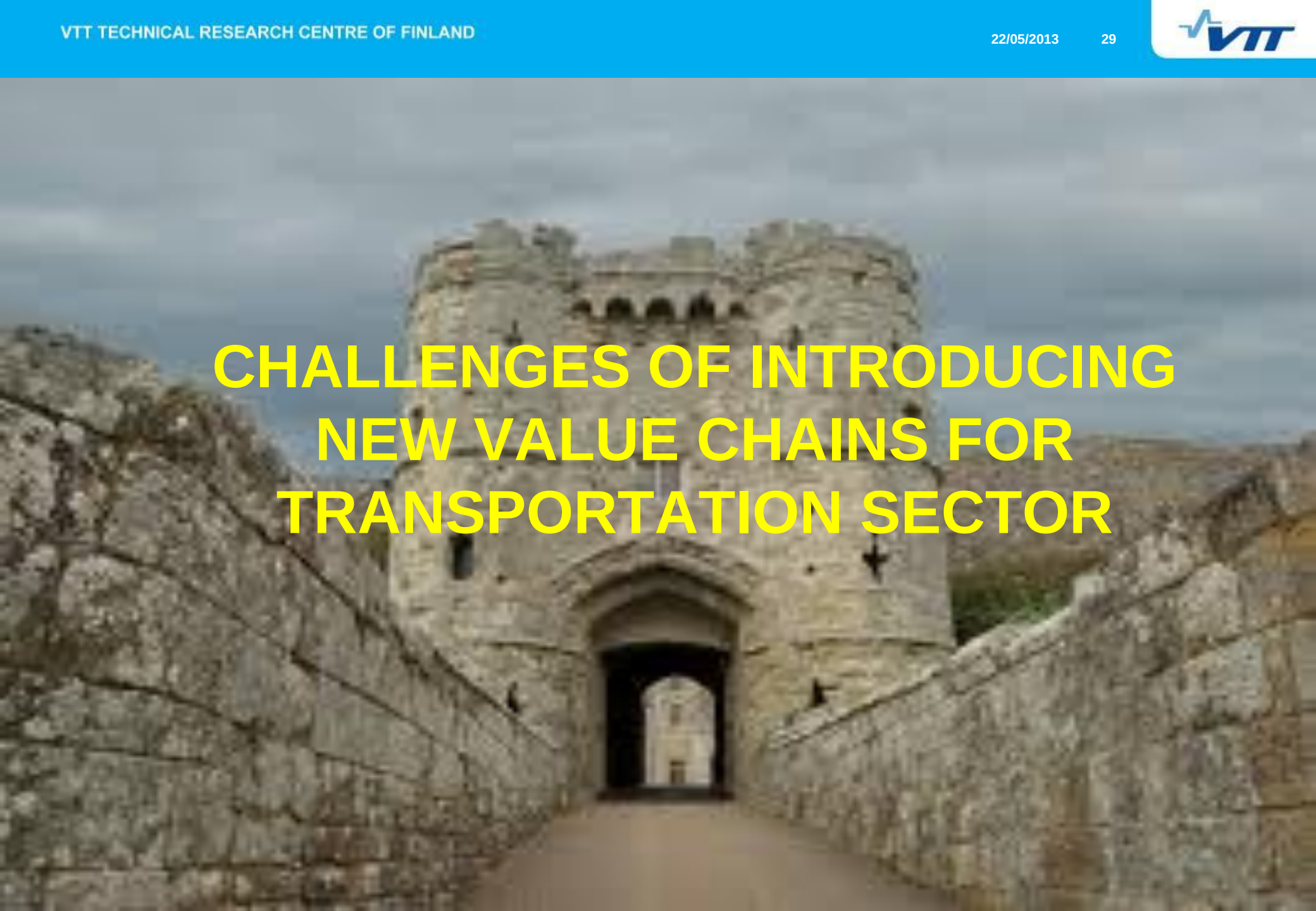
The background of the slide is a photograph of three golden trophies. The trophies are arranged in a row, with the one in the foreground being in sharp focus and the two behind it being slightly blurred. They are all made of a shiny, reflective gold material. The word 'Opportunities' is overlaid in the center of the image in a large, white, sans-serif font.

Opportunities

With the Introduction of Electricity as "Fuel", a New Value Chain Can Emerge

- Electricity generation is much more diversified and localised than present-day transportation fuel supply
 - ***Security of supply is inherently quite high***
- Power grid is relatively widespread
 - ***Must only concentrate to the "last five meters"***
- Quality is not an issue - "one size fits all"
 - ***No need to segregate "transportation-quality" electricity***
- Also many fairly large, multi-national companies
 - ***Ability to invest, if new market is foreseen***
- But: Grid balance must be secured
 - ***Generation capacity must be exploited wisely: "Smart Grid"***



The background of the slide is a photograph of a large, ancient stone castle tower. The tower is made of light-colored, weathered stone blocks and features a prominent arched entrance at its base. The sky above is overcast with grey clouds. The title text is overlaid on the center of the image.

CHALLENGES OF INTRODUCING NEW VALUE CHAINS FOR TRANSPORTATION SECTOR

Nº 1 - STAGNANT AND SLOW-CHANGING BUSINESS

- Status Quo for the sector is quite stagnant, because:
 - Very large global companies are overruling both stages
 - Huge incumbent investments
 - Long history and legacy, some companies over 100 years old
 - High degree of technology with emphasis on quality vs. price
- Strong competition between companies, but simultaneously strong and united opposition against newcomers



Nº 2 - “THE GATEKEEPERS”

- to be able to introduce a new fuel or energy carrier you must seek consent with the “Gatekeepers”
- Why?
- Because each one has his own key, and you need all of them:
 - **Auto industry** controls vehicle and engine technology
 - **Oil industry** controls the fuel and distribution infrastructure
 - **Financial sector** controls capital for new investments needed



AUTO INDUSTRY's KEY

- you must agree with the auto industry, because...
 - if the new energy product needs new storage and conversion devices on-board, like electricity or hydrogen, new cars are needed
 - considerable lead-time needed, if new technology is needed, as the auto industry has a legacy of safeguarding high quality and “crashproofness” of their products



OIL INDUSTRY's KEY

- you must agree with the oil industry, because...
 - if the new product is suitable for blending with the existing fuels, it can be distributed via the existing infrastructure
 - however, lead-time needed here also to ensure compatibility of the new product with the existing and future vehicle park
 - if it does not fit in with the existing standards, must develop new



FINANCIAL SECTOR's KEY

- you must agree with the financial sector, because...
 - if your product is non-compatible with the existing fuels, and there is no existing infrastructure for it, you must build one
 - Building new system will require heavy long-term investments, where growth of revenue and pay-back times will be very long
 - New fuel or energy need to be offered quite widely before consumers can commit themselves, unless bimodal cars are used



Nº 3 - ATTITUDE

**“WE WELCOME YOUR NEW IDEAS, INVENTIONS
AND INNOVATIONS WITH GREAT ENTHUSIASM!”**



Are We in a Dead-end?

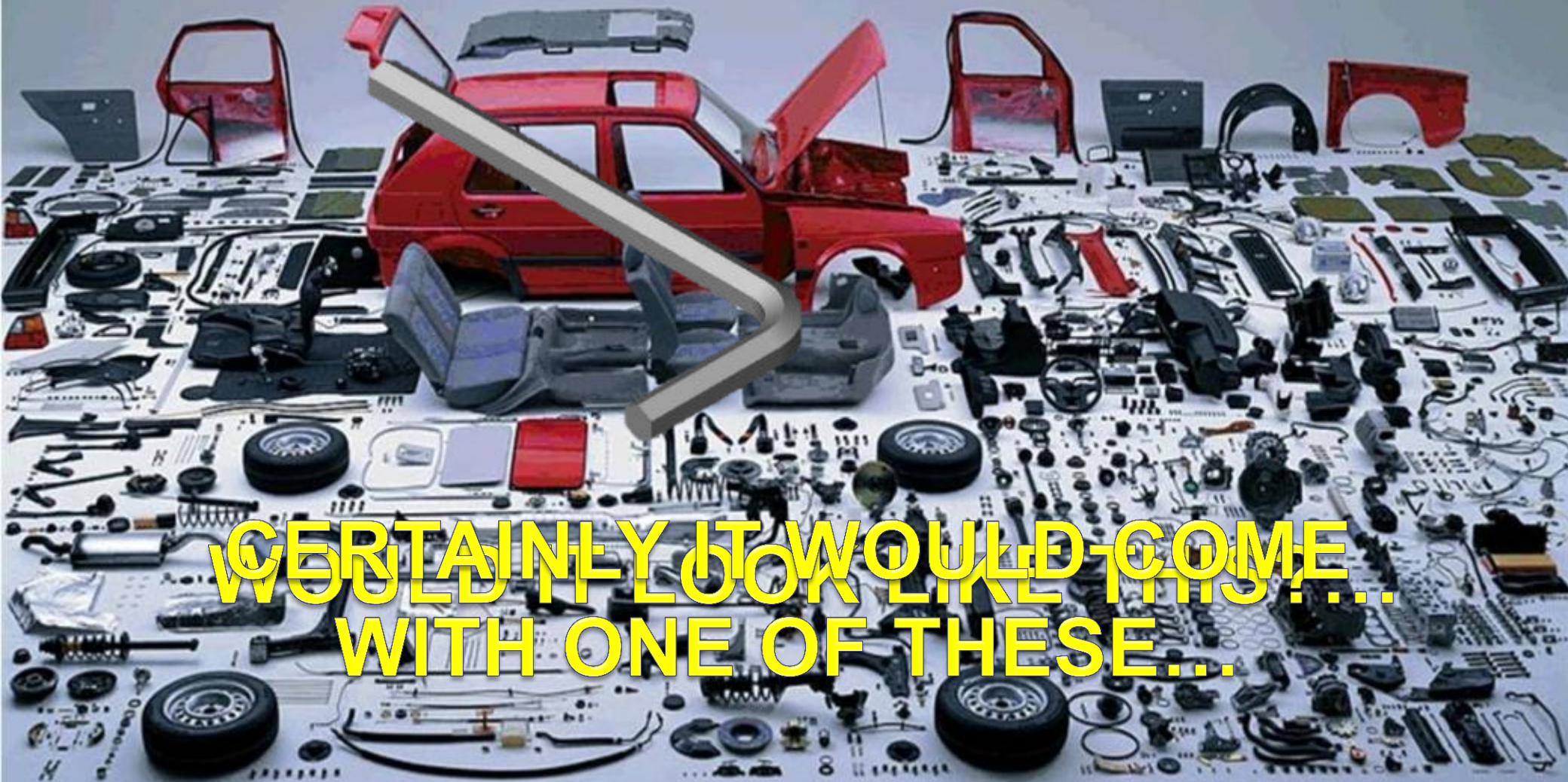


IS THE CURRENT BUSINESS MODEL THE ONLY WAY TO SUCCESS?



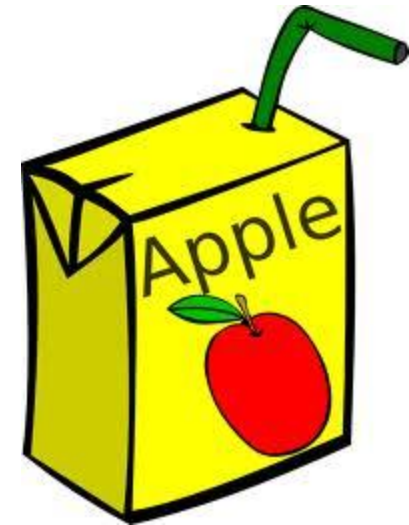
WHAT IF IKEA WOULD START SELLING CARS...

CERTAINLY IT WOULD COME
WOULD IT LOOK LIKE THIS?...
WITH ONE OF THESE...



WHAT IF APPLE WOULD START SELLING CARS...

Introducing the iCar



Apple

**LIKELY IT WOULD RUN
JUST WITH THIS!**

WHAT IF APPLE WOULD START SELLING CARS...

Introducing the iCar



Apple

...PROBABLY YOU WOULD ALSO
STEER IT BY WAVING YOUR HANDS!

CAN WE REALLY SEE THE GAME TO CHANGE?



YEAH, SOME REFRESHING NEW IDEAS, BUT...



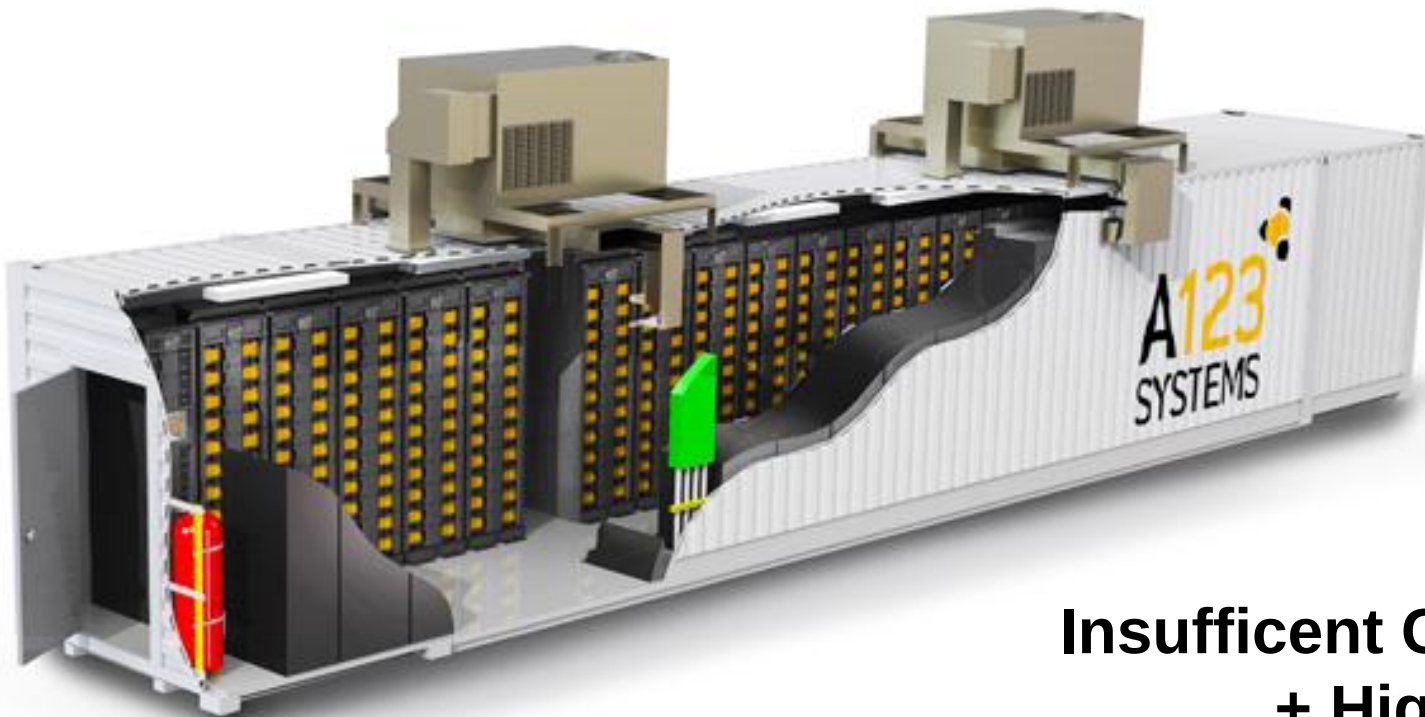
Who is the Scapegoat?



SCAPEGOAT

The Secret To Success Is Knowing Who To Blame

Show-stopper N° 1 – "Battery Technology Sucks!"



**Insufficient Capacity
+ High Costs
+ High Risks (lifetime?)
= Stay Away From It!**

“Take A Detour Instead”





“FUEL OF CHOICE” by the Auto Industry



CHEERS:

- **Even Higher Potential for Use of Renewable Energy Resources**
- **Decent Range with One Fill, and Fill-up Time Like with Petroleum Fuels**
- **High Efficiency of the Electric Drivetrain**
- **Fossil (Methane Reformate) Option Offers Nearly-decent Entry-level Cost per MJ**

JEERS:

- **Must Find Capital & Partners to Create Distribution Infrastructure**

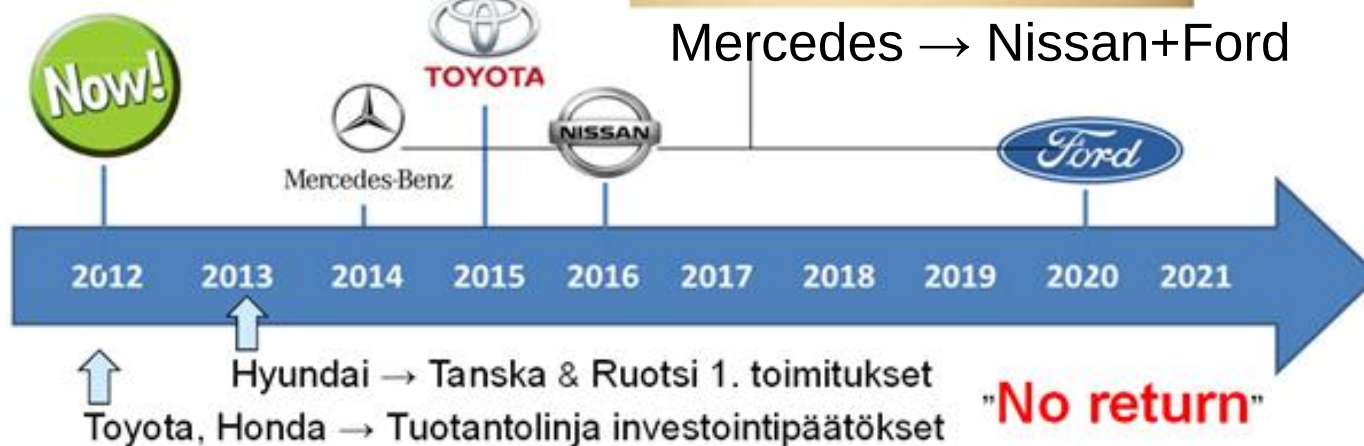
New automotive **alliances** have been formed
for FCEV commercialization **in January 2013**

Timeline for Introduction

"Toyota FC → BMW"



Mercedes → Nissan+Ford

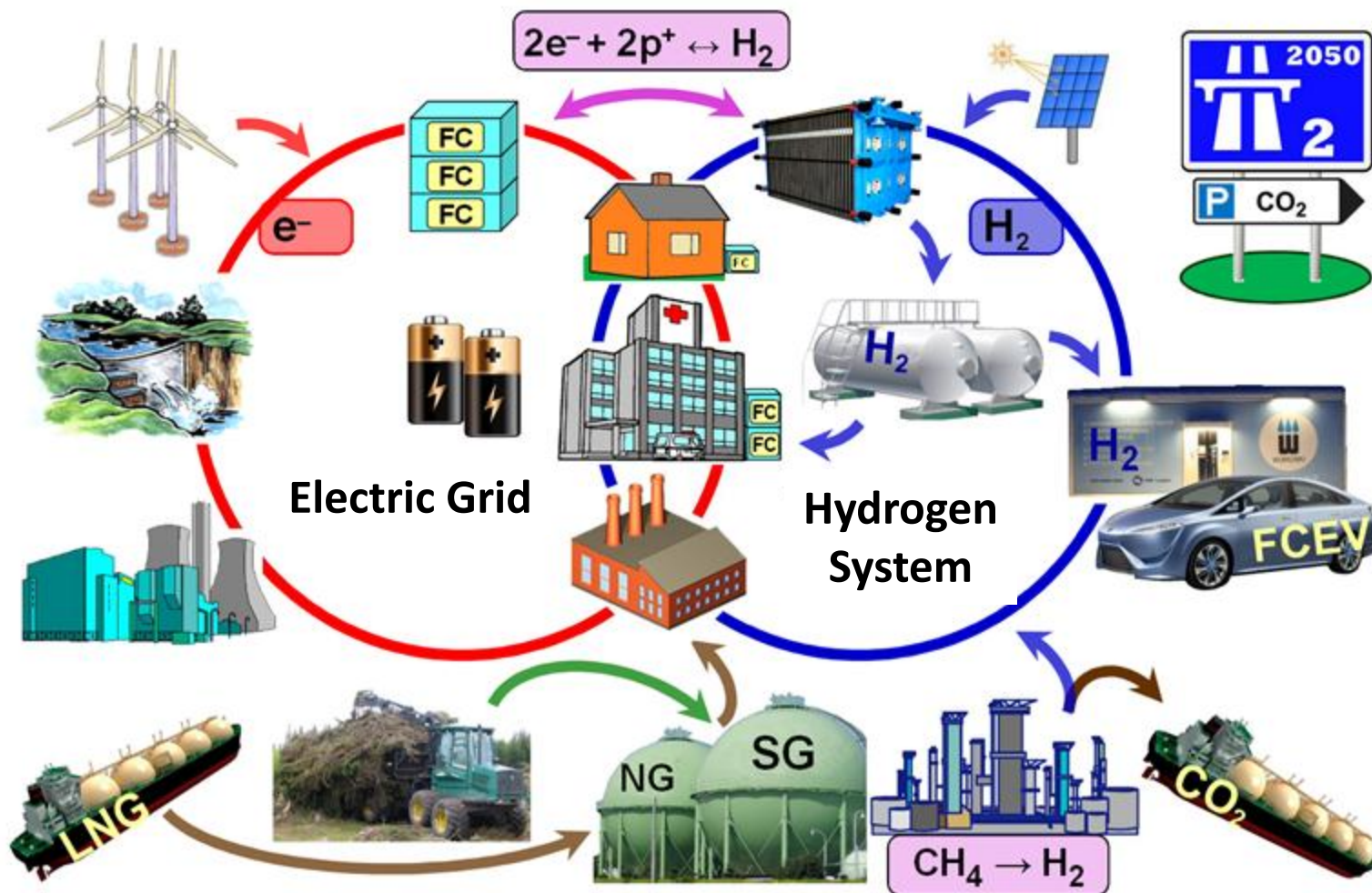


“We Are Ready to Roll-Out”

Production > 100k by 2015

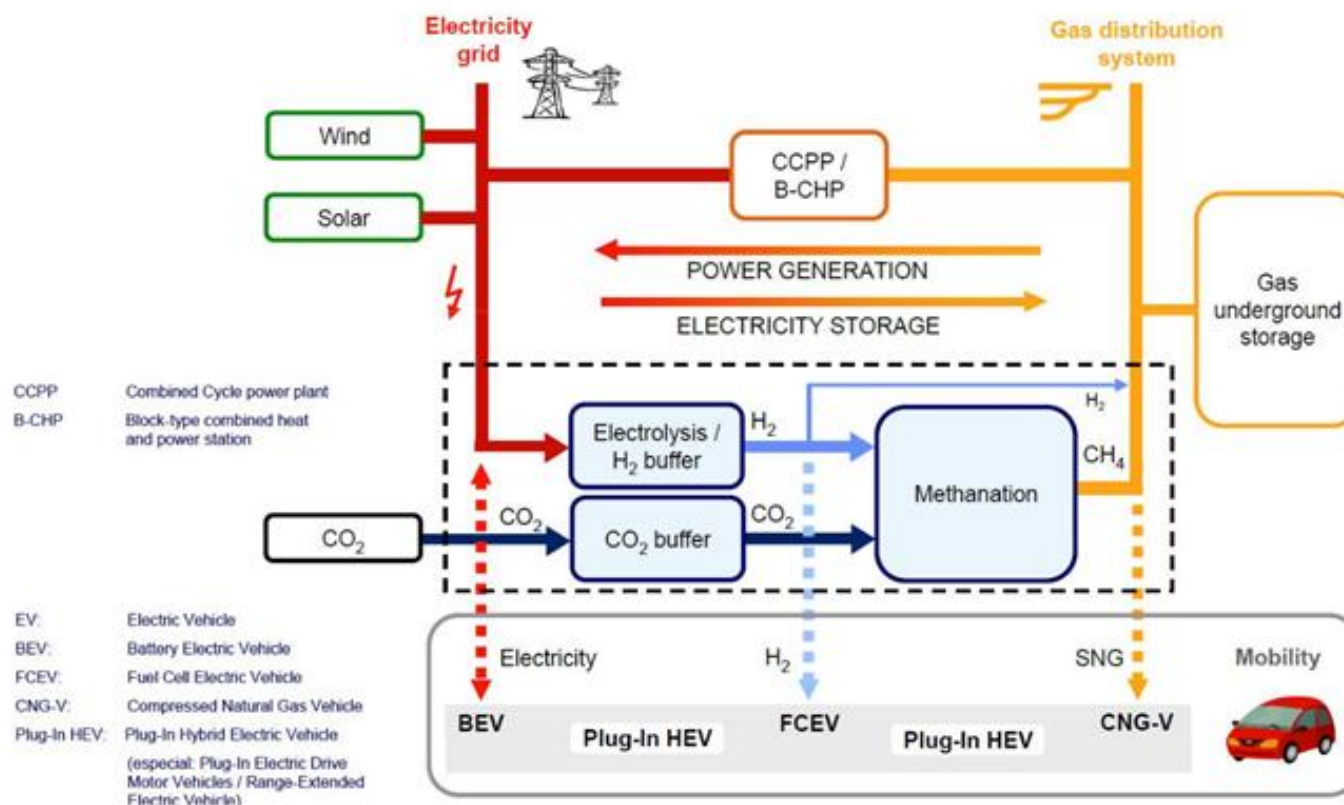


Integrated Energy System of the Future



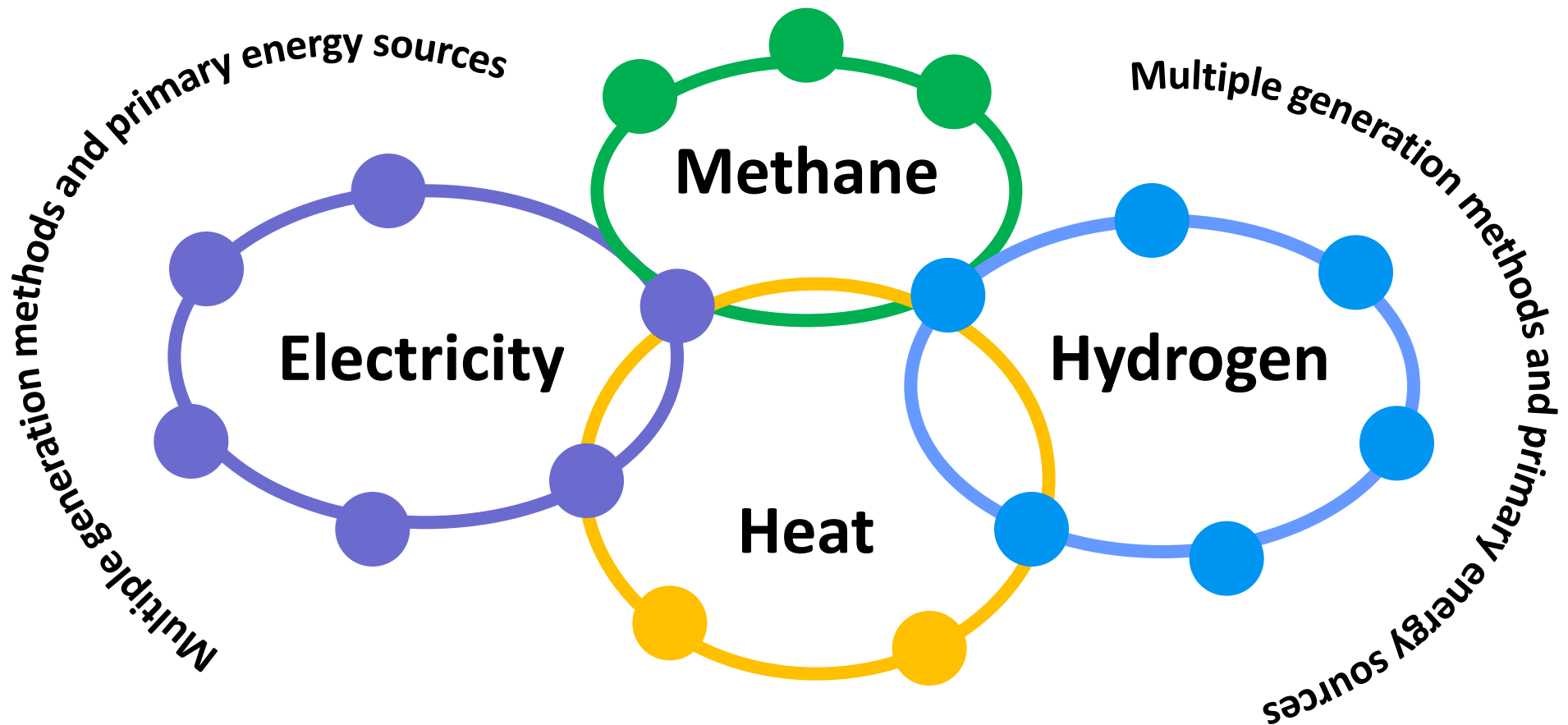
Integrated Energy System of the Future

Power-to-Gas (P2G) - Concept: Interconnection with Mobility



German "Power to Gas" concept by Michael Specht, ZSW. see <http://www.powertogas.info/>

Parallel, Co-working "Energy Circles" with Binding, Two-way Nodes



**What is the Critical
Piece of the Puzzle?**



The Last Necessary Piece is...

“Lots of Lazy Capital”

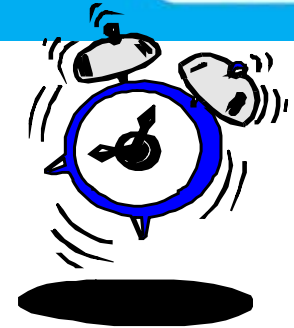


CONCLUSIONS

- ***The Future cannot be predicted, but we can influence it***
 - It is based on our decisions and actions, not “God Given”
- ***The basis of the Future lies in today, mostly linear change***
 - So far, no strong disruptive game-changers
- ***Automotive/transportation sector is slow to change***
 - Huge, incumbent investments
 - Longish product cycle and vehicle lifetime

CONCLUSIONS

- ***Future challenges cannot be met with just one energy carrier***
 - Several co-existing fuels/energies and conversion technologies
 - However, future carriers are non-specific to transport use
- ***Lately, revolution has gotten more attention than evolution***
 - Strong battery-electric car hype, but poor industry support
 - Hydrogen fuel cell is seen more viable by the Auto industry
- ***Strong, incumbent actors rule the stage and slow-down change***
 - New and innovative value chains are difficult to create, even if lucrative
- ***Furthermore, we must always keep in mind***
 - “Affordability”, market-acceptance and trust of the consumers
 - You cannot mandate vehicle sales!



The End

Questions & Discussion

- Thank you for your attention!

