

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 detailed, futuristic cityscape. The architecture is highly advanced, with tall, dark, metallic structures and intricate, lattice-like designs. The city is set against a dramatic sky with a bright sun low on the horizon, creating a golden glow and long shadows. The overall atmosphere is one of a advanced, industrial civilization.

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...

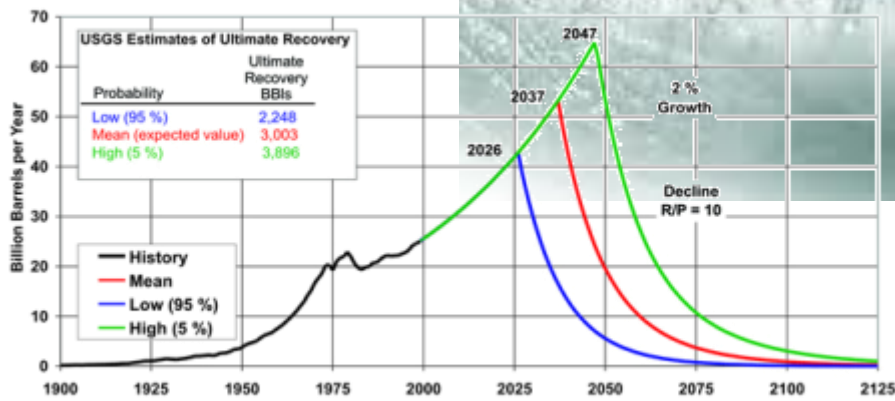


...Now!

Code	Date	Open	High	Low	Last	Volume	Price	Close	Bid	Ask	Name
3AC	3/31/2005	1.96	1.96	1.95	1.95	212118	1.95	1.94	0.55	0.57	3AC FPO
3AE	3/31/2005	0.29	0.30	0.19	0.22	13306	0.19	0.18	0.185	0.19	3AE ETHANO FPO
3AJ	3/31/2005	0	0	0	0	0	0	0	0	0	3AJ ALCTA CEE
3AM	3/31/2005	0.288	0.291	0.289	0.291	103819	0.291	0.290	0.29	0.29	3AM MIBESOL FPO
3AQ	3/31/2005	0.55	0.60	0.55	0.67	404417	0.54	0.66	0.67	0.67	3AQ AUST AQVA FPO
3AA	3/31/2005	0.84	0.94	0.837	0.937	6293914	0.839	0.937	0.938	0.937	3AA AMGLD FPO
3AT	3/31/2005	0.175	0.175	0.175	0.175	10906	0.17	0.17	0.17	0.17	3AT AUSTON FPO
3ATD	3/31/2005	0	0	0	0	0	0	0	0	0	3ATD AUSTON OPT XAOT
3AU	3/31/2005	1.34	1.36	1.14	1.35	1399576	1.14	1.18	1.35	1.35	3AU ADCORP AUR FPO
3AB	3/31/2005	6.6	6.70	6.54	6.70	46378	6.51	6.58	6.70	6.70	3AB GRAM FPO
3AC	3/31/2005	1.81	1.83	1.81	1.81	630703	1.81	1.81	1.81	1.81	3AC AUST OPT FPO
3AR	3/31/2005	0.12	0.125	0.113	0.125	10841392	0.11	0.12	0.125	0.125	3AR AMRZ LTO FPO
3ABK	3/31/2005	0.155	0.155	0.155	0.155	5306	0.155	0.155	0.155	0.155	3ABK AUST BACK FPO
3ABCH	3/31/2005	0	0	0	0	0	0	0	0	0	3ABCH AUST MTR SEPOE
3ABCHB	3/31/2005	0	0	0	0	0	0	0	0	0	3ABCHB AUST MTR SEPOE
3ABCHC	3/31/2005	0	0	0	0	0	0	0	0	0	3ABCHC AUST MTR SEPOE
3ABCHD	3/31/2005	0	0	0	0	0	0	0	0	0	3ABCHD AUST MTR SEPOE
3AB	3/31/2005	1.37	1.37	1.35	1.36	94522	1.37	1.36	1.36	1.36	3AB AUSTO STARLTD
3AQ	3/31/2005	0.388	0.4	0.388	0.4	6294	0.39	0.388	0.4	0.4	3AQ AUSTO STARLTD
3AS	3/31/2005	5.47	5.54	5.44	5.5	38804	5.47	5.5	5.51	5.51	3AS AUSTO STARLTD
3ASB	3/31/2005	0	0	0	0	0	0	0	0	0	3ASB AUSTO STARLTD
3ASBPA	3/31/2005	0	0	0	0	0	0	0	0	0	3ASBPA AUSTO STARLTD
3ACDB	3/31/2005	0	0	0	0	0	0	0	0	0	3ACDB AUSTO STARLTD
3ACDHB	3/31/2005	0	0	0	0	0	0	0	0	0	3ACDHB AUSTO STARLTD
3ACDHC	3/31/2005	0	0	0	0	0	0	0	0	0	3ACDHC AUSTO STARLTD
3ACDHD	3/31/2005	0	0	0	0	0	0	0	0	0	3ACDHD AUSTO STARLTD
3AC	3/31/2005	0.72	0.72	0.7	0.7	37218	0.72	0.7	0.72	0.72	3AC AUSTO STARLTD
3ACB	3/31/2005	0.7	0.72	0.68	0.72	36820	0.68	0.72	0.72	0.72	3ACB AUSTO STARLTD
3ACU	3/31/2005	0.195	0.195	0.195	0.195	823906	0.195	0.195	0.195	0.195	3ACU AUSTO STARLTD
3ACV	3/31/2005	0	0	0	0	0	0	0	0	0	3ACV AUSTO STARLTD



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



s for Europe:




The role of Battery Electric Vehicles, Plug-in Hybrids and Fuel Cell Electric Vehicles



ic



UNDERSTANDING ELECTRIC VEHICLE TECHNOLOGY — ENVIRONMENTAL BENEFITS



On the Road in 2035

Reducing Transportation's Petroleum Consumption and GHG Emissions

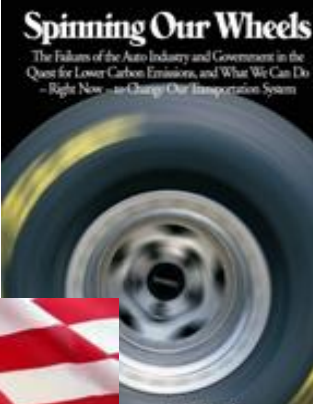
Asap Bandopadhyay
Kristina Brink
Lyndee Chubb
Christopher Evans
Tiffany Goodie
John Heywood
Ercan Karadas
Matthew Kramer
Markus Weiss

Mit

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



By Pat Murphy
author of *Plan C: Community Survival Strategies for Peak Oil and Climate Change*


J.D. POWER
RESEARCH ASSOCIATES

Drive Green 2020: More Hope than Reality?



A Special Report by
and Associates.

November 2010



A Global Mobility




2050
2045
2040
2035
2030

Technology Roadmap


Electric and plug-in hybrid electric vehicles



CLIMATE AND TRANSPORTATION SOLUTIONS

Findings from the 2009 Asilomar Conference on Transportation and Energy Policy

DANIEL SPERLING AND JAMES S. CANNON (EDITORS)



ITS UC DAVIS
INSTITUTE OF TRANSPORTATION STUDIES

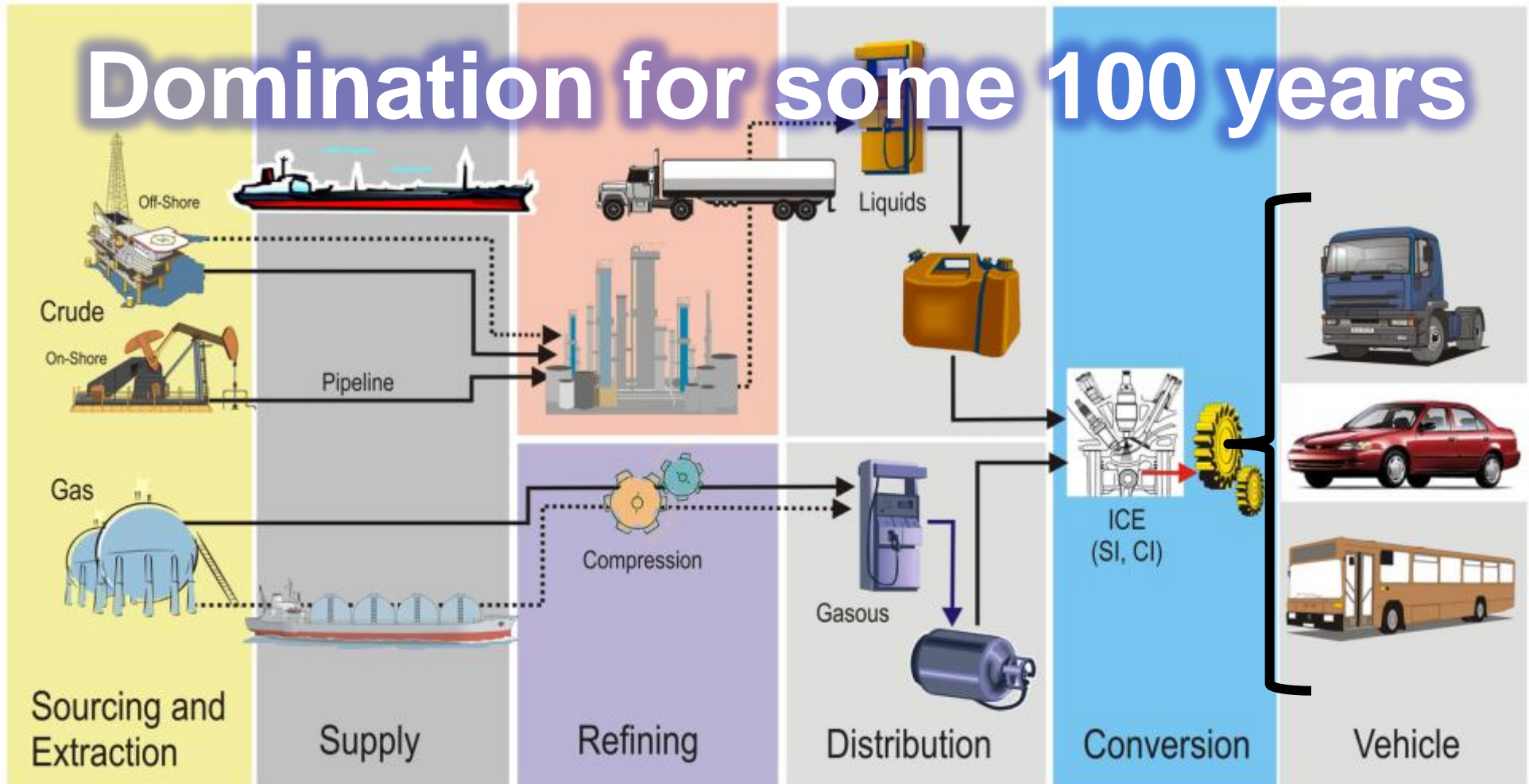
What Ultimately Determines the Future?

- 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

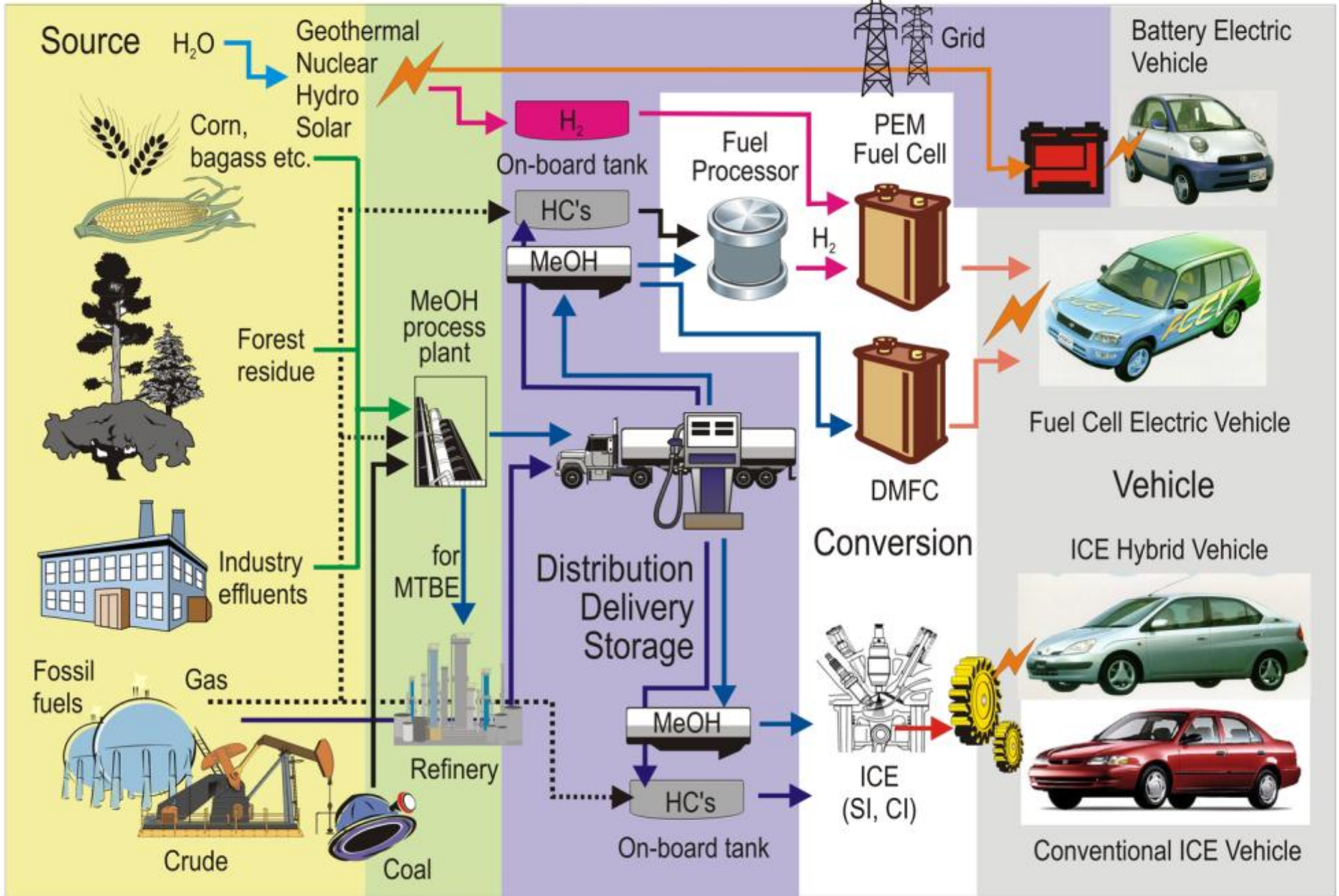


“The Race is On”

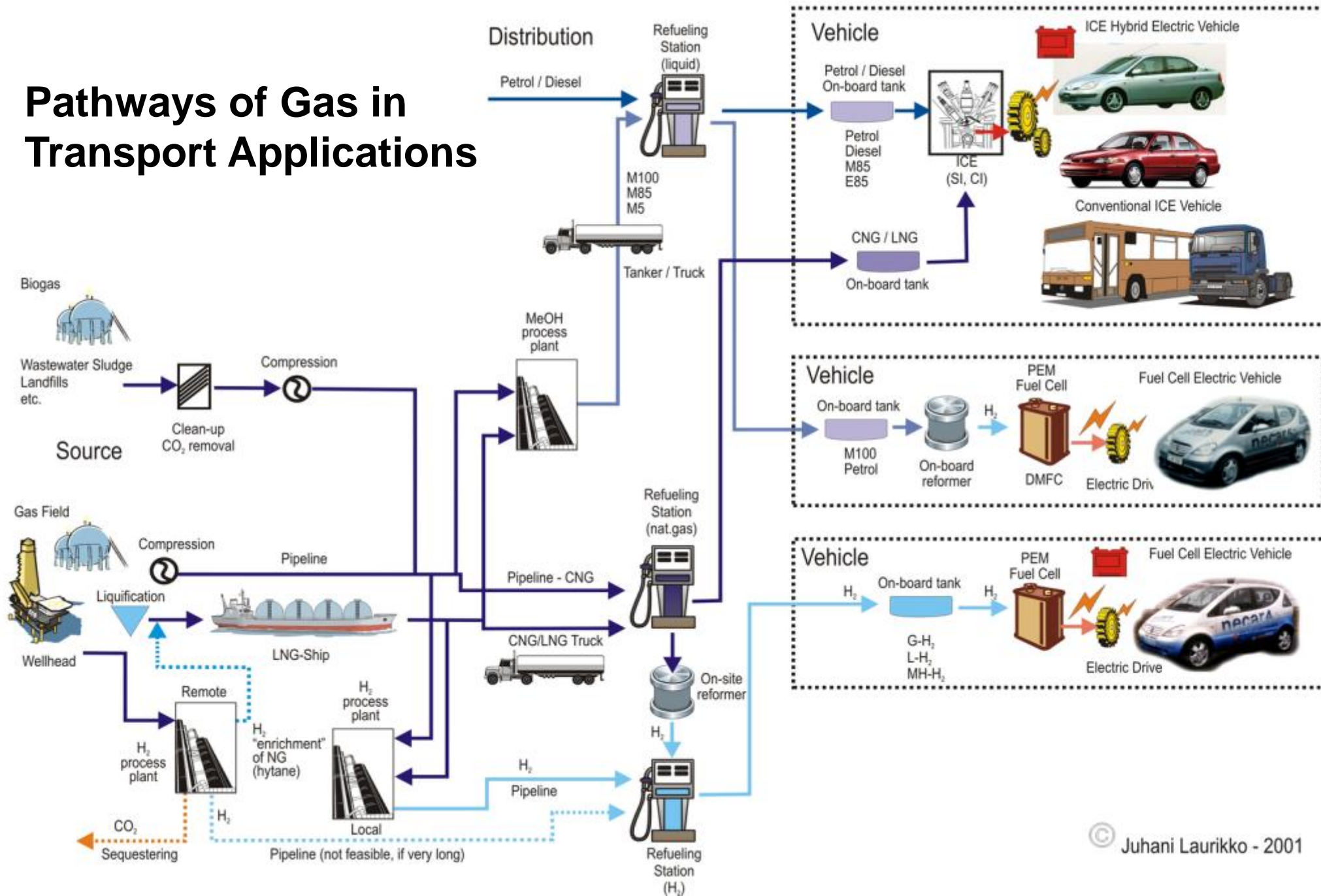


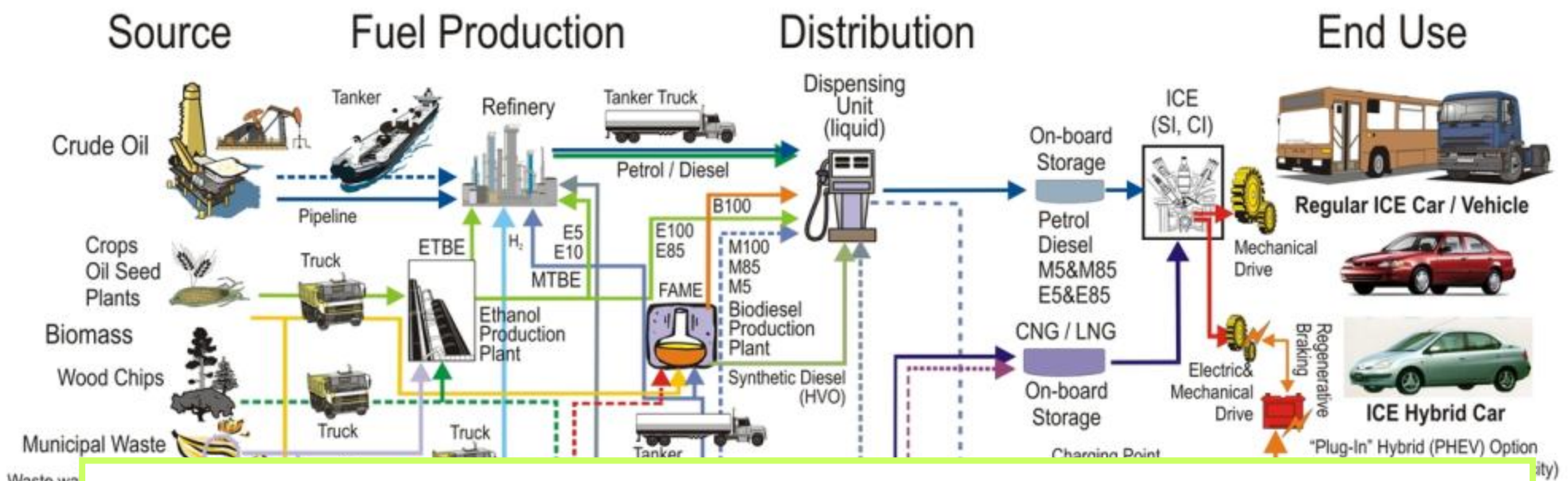
Pathways of Fuels & Energies in Transport Energy Use

(c) Laurikko - 2001

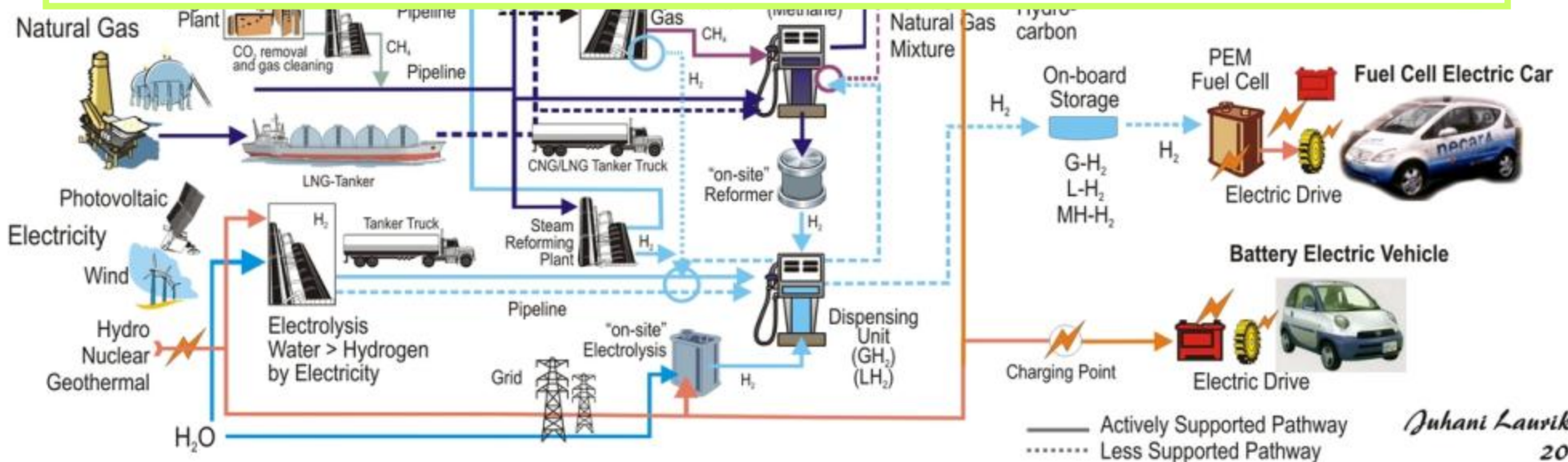


Pathways of Gas in Transport Applications



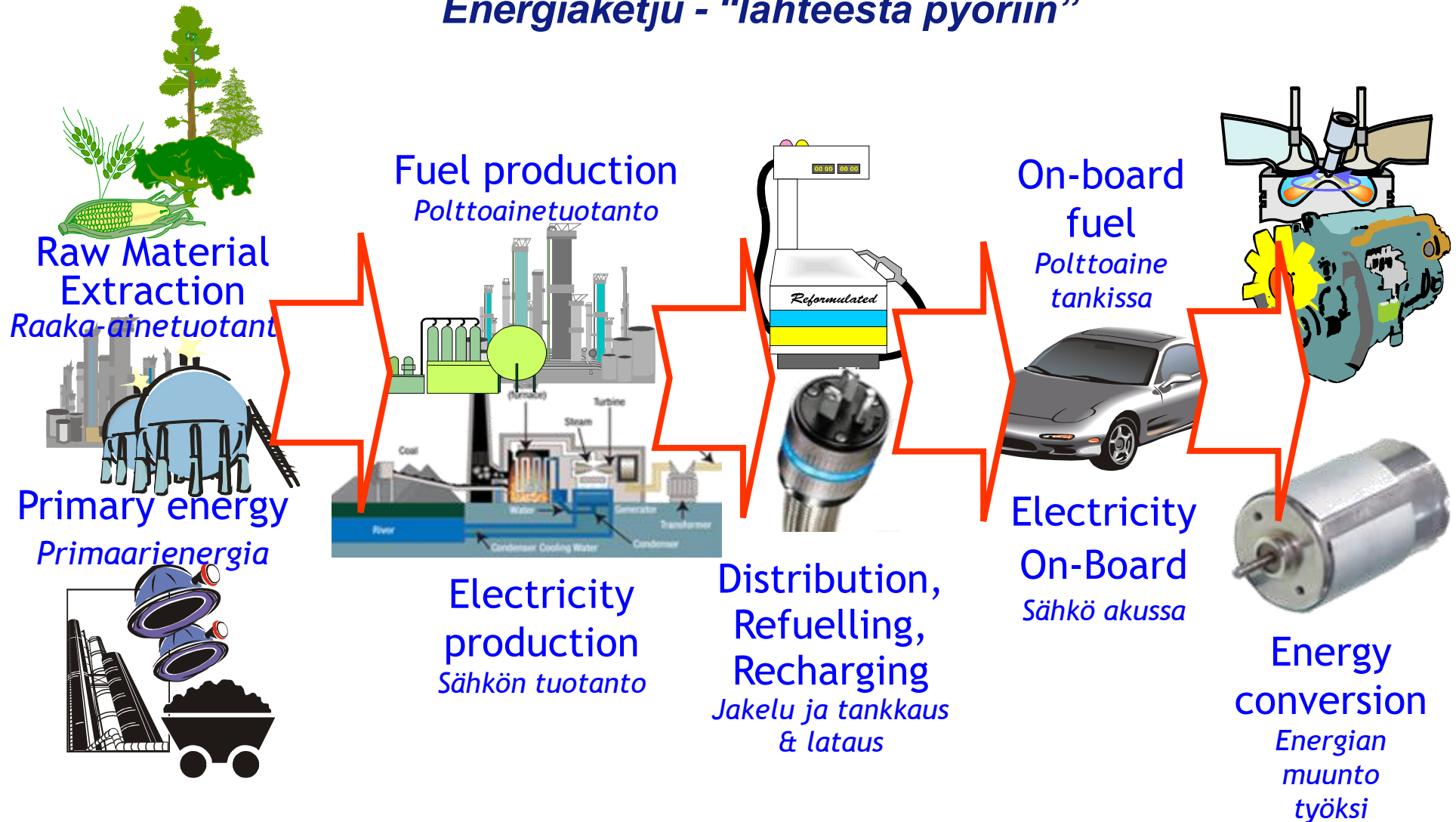


In pure technical terms the options are numerous, but not all are competitive!



Pathway analysis – Well-to-Wheels (WTW)

Energiaketju - "lähteestä pyöriin"



Critical Issues

Kriittiset tekijät

Abundance

Saatavuus

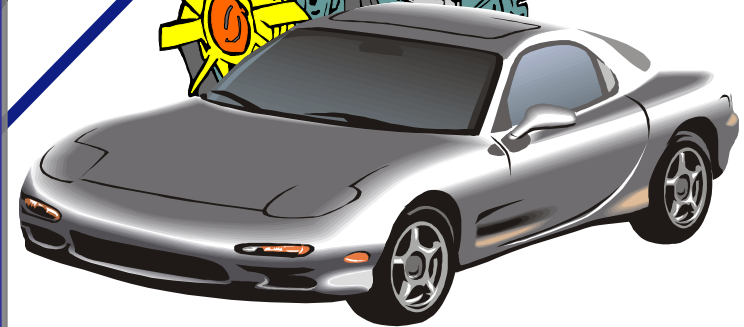
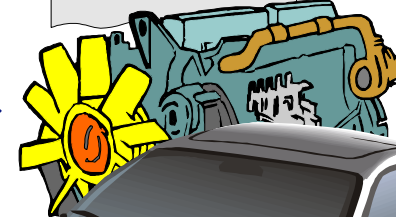
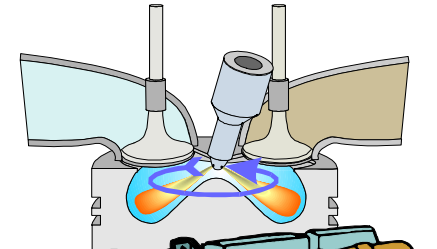
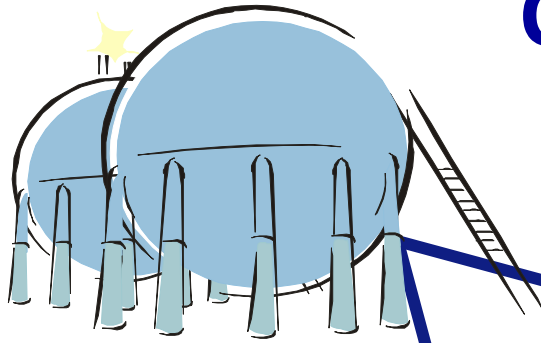
**Any one
of these
can set
the limit!**

**Compatible
engines&vehicles**

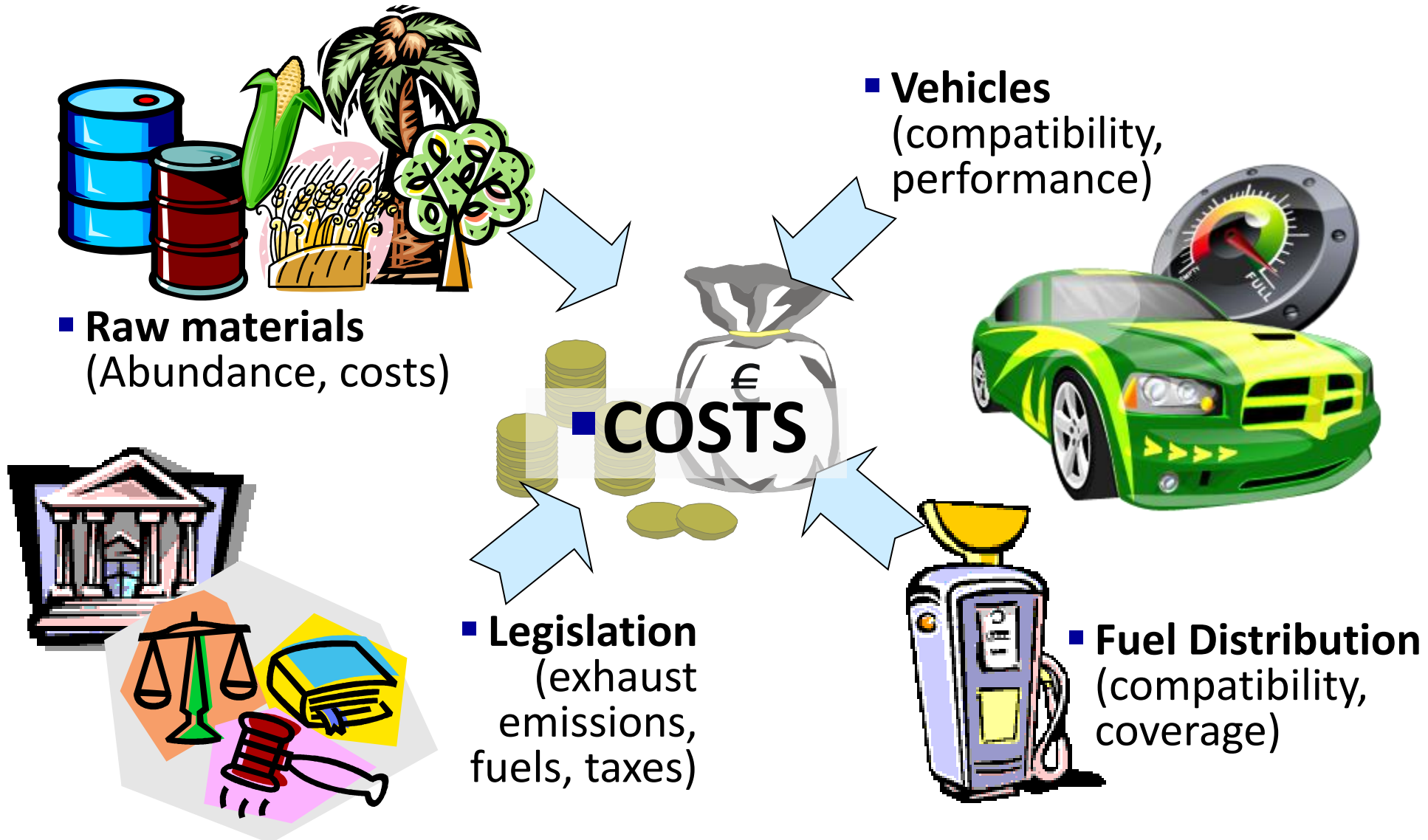
Yhteensopiva kalusto

**Refuelling
infrastructure**

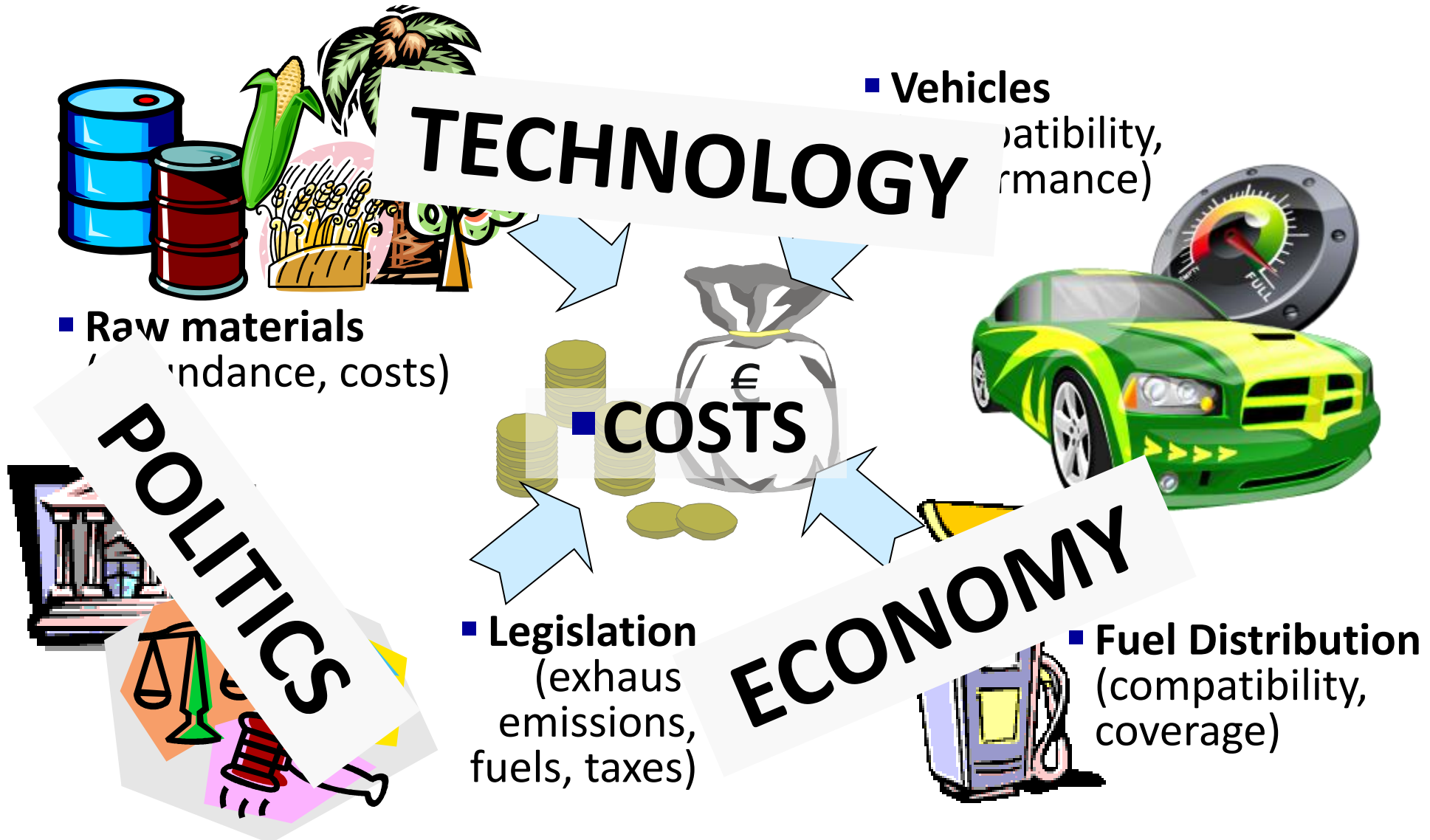
Polttoainejakelu



KEY DRIVERS IN THE OPERATIONAL ENVIRONMENT



KEY DRIVERS IN THE OPERATIONAL ENVIRONMENT



A perspective view of a dark asphalt road with white dashed and solid lines, stretching towards the horizon. The road is flanked by grassy hillsides. The sky is a vibrant blue with bright sun rays emanating from the top right corner, creating a sense of depth and optimism.

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

Use the Right Tools



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A Nordic Energy Research Project

Nordic Pathways for Sustainable Transport and Energy

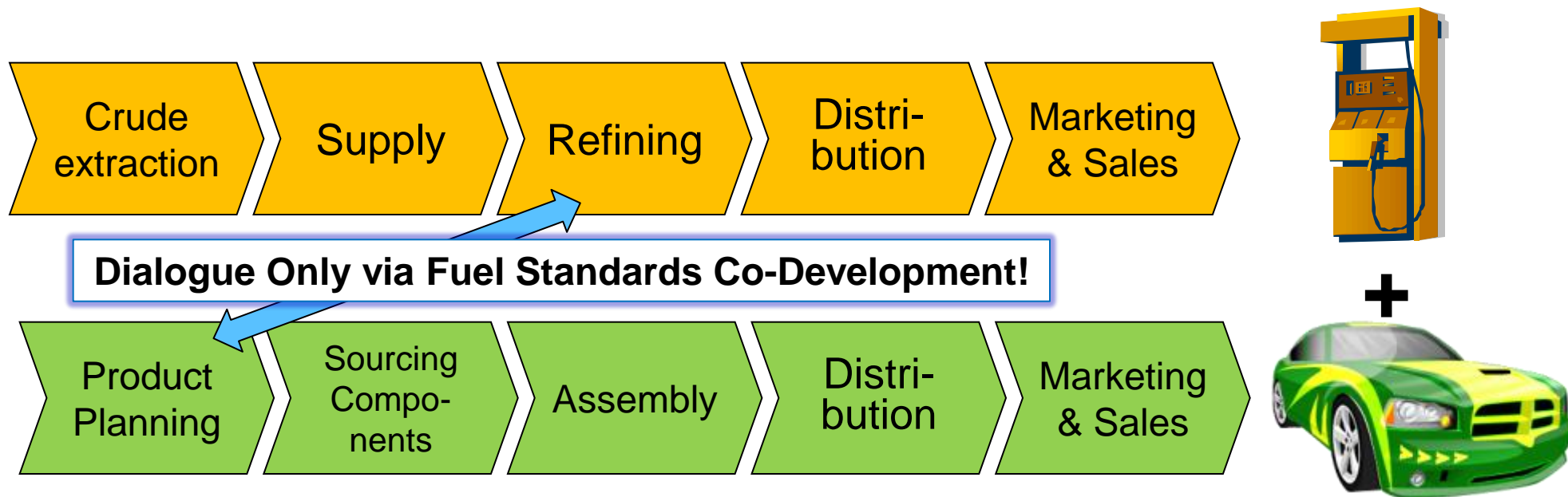
Latest news

- [Nordic Biofuels Policy Report](#)
- [TOP-NEST profile in Pan-European Network](#)
- [1st Annual Seminar in Espoo](#)
- [Welcome to new project members, September 2012](#)
- [TOP-NEST profiled in Public Service Review, 23 issue, 2012](#)

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

Present-day Value Chains of Cars & Fuels



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

A photograph of three golden trophies, likely made of brass or gold, arranged in a row. The trophies are cup-shaped with two handles and a base. They are set against a warm, golden-brown background. The word "Opportunities" is overlaid in white, bold, sans-serif font across the center of the trophies.

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"***



A photograph of a stone castle tower with a central arched entrance, set against a cloudy sky. The tower is made of light-colored stone blocks and has a crenellated top. The entrance is a dark, arched doorway leading to a smaller, white structure in the distance.

CHALLENGES OF INTRODUCING NEW VALUE CHAINS FOR TRANSPORTATION SECTOR

N° 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



N° 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



TOYOTA



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



N° 3 - ATTITUDE

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



Shell



TOYOTA



Are We in a Dead-end?



IS THE CURRENT BUSINESS MODEL THE ONLY WAY TO SUCCESS?



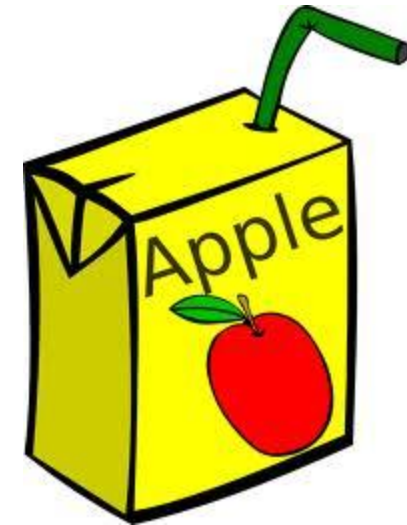
WHAT IF IKEA WOULD START SELLING CARS...



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

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...



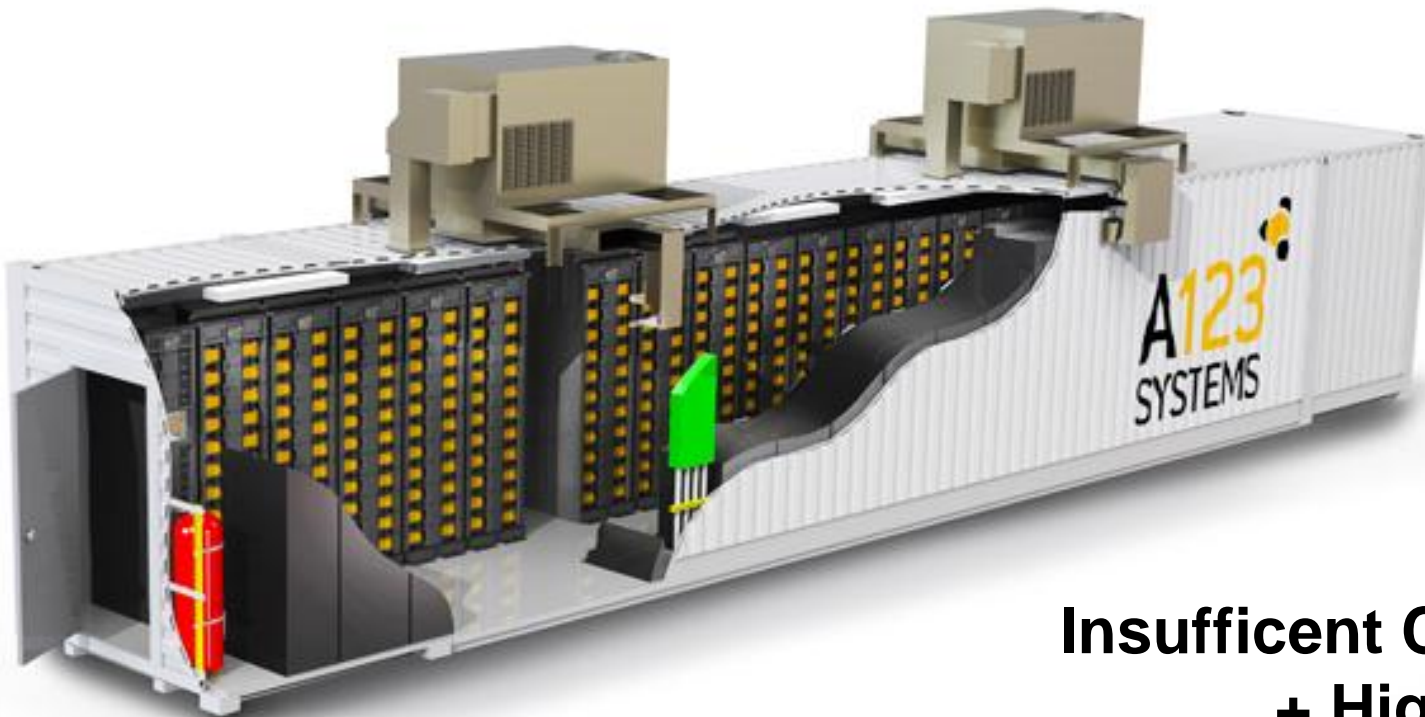
Who is the Scapegoat?



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”





D 820

H₂

"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

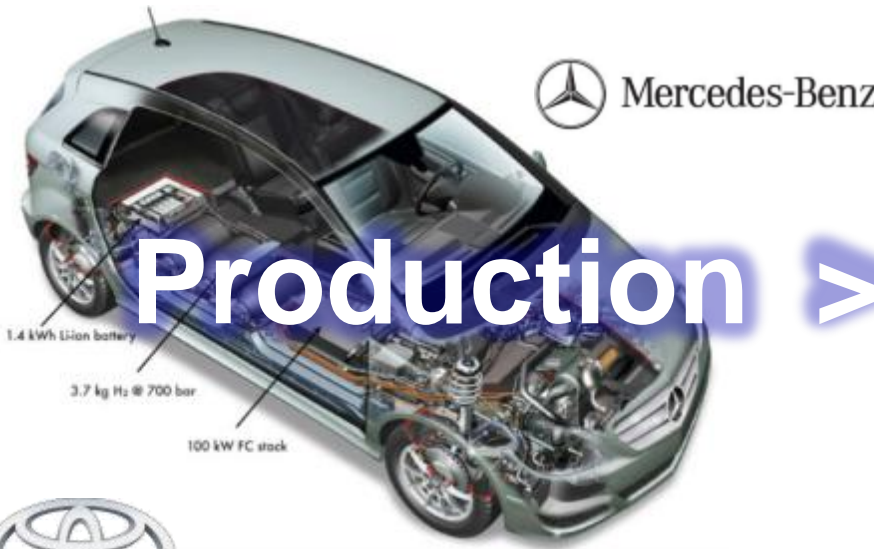


Mercedes → Nissan+Ford

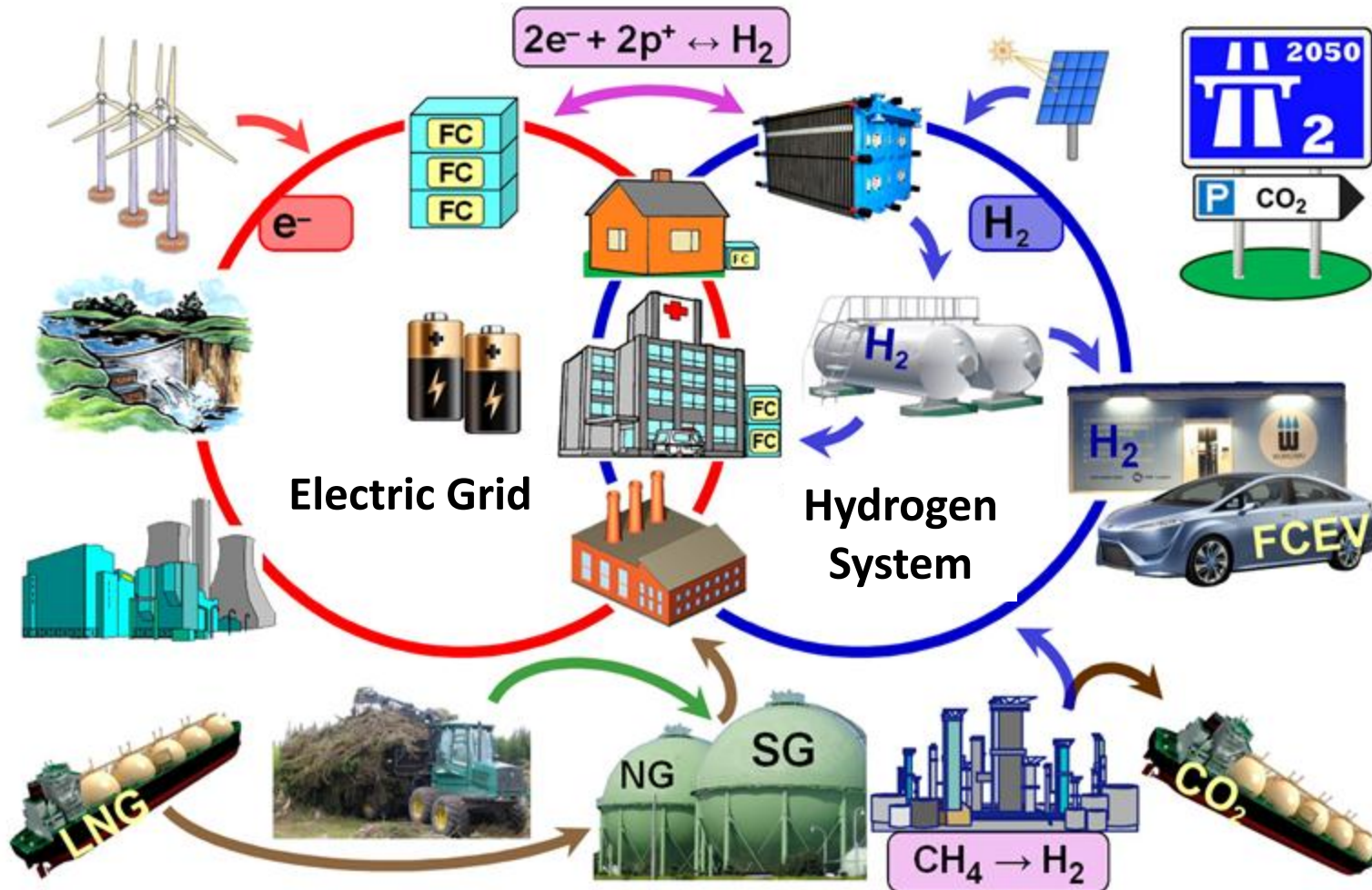


"We Are Ready to Roll-Out"

Production > 100k by 2015

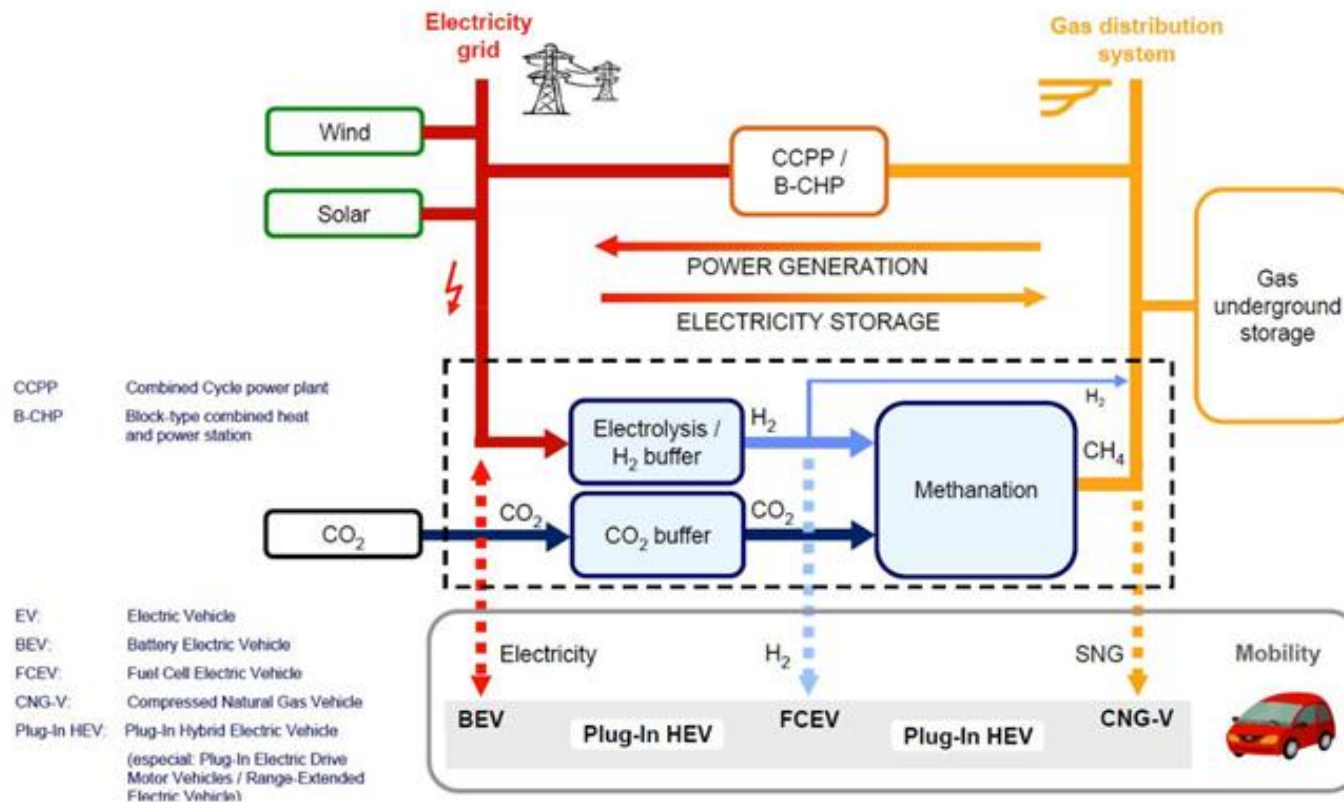


Integrated Energy System of the Future



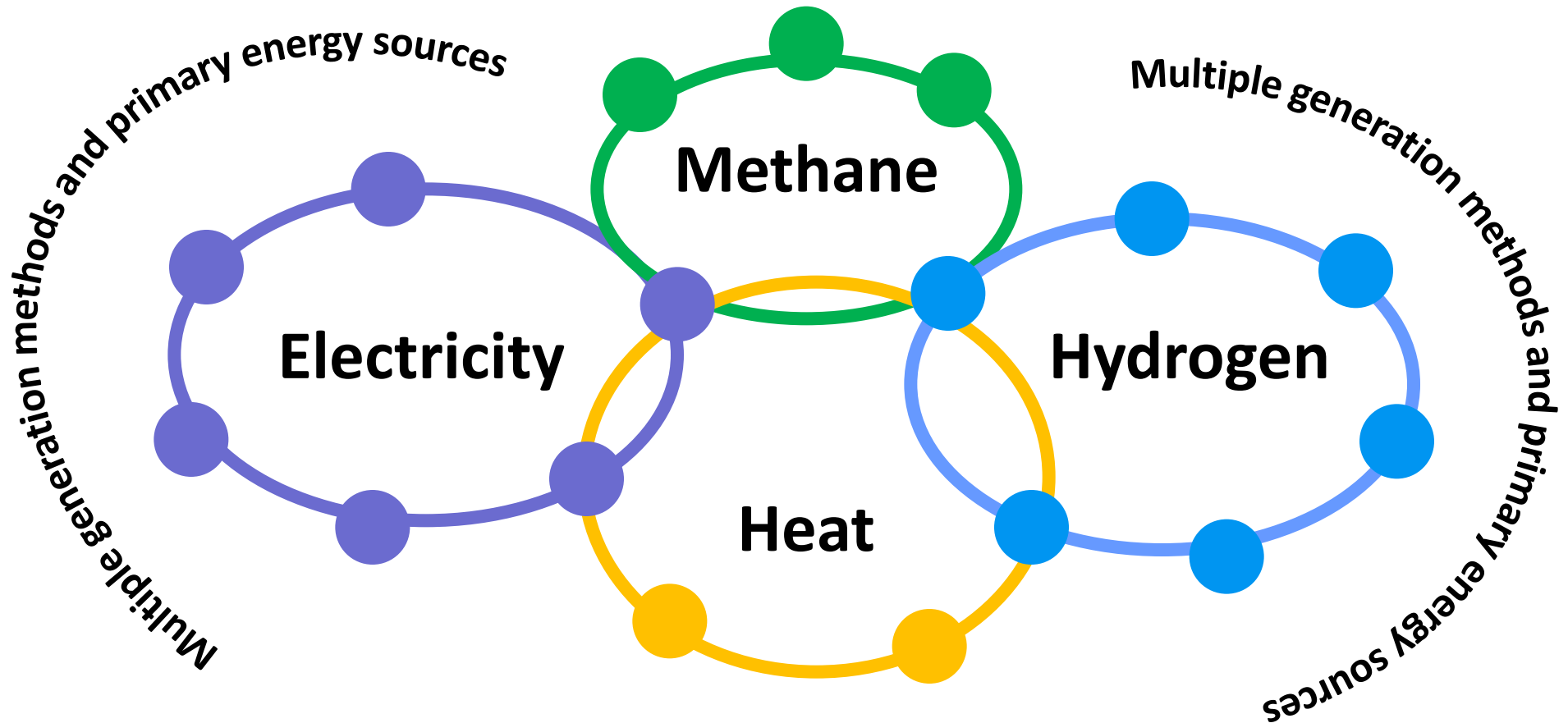
Integrated Energy System of the Future

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



A blue puzzle with one piece missing, highlighted by a spotlight. The puzzle is composed of many interlocking pieces, and the missing piece is a single white piece. A bright light beam from the top left corner of the image illuminates the white piece, making it stand out against the blue background. The text "What is the Critical Piece of the Puzzle?" is overlaid on the image in a white, sans-serif font.

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

The Last Necessary Piece is...



“Lots of Lazy Capital”

CONCLUSIONS

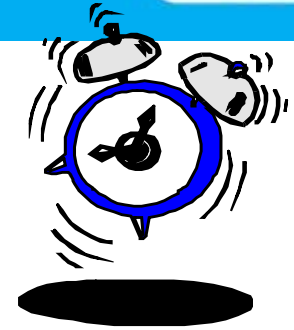
- ***The Future cannot be predicted, but we can influence it***
 - It is based on our decisions and actions, not “God Given”
- ***The basis of the Future lies in today, mostly linear change***
 - So far, no strong disruptive game-changers
- ***Automotive/transportation sector is slow to change***
 -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

