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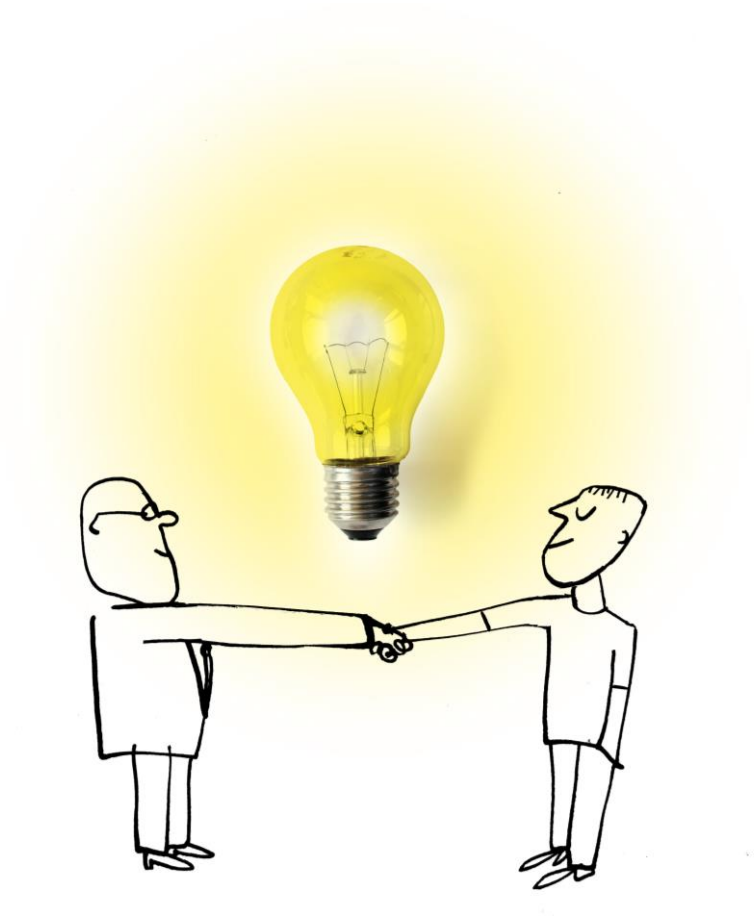

Towards a CO_2-neutral hydrogen economy

5 THESES BY GOETZPARTNERS & FUTURE CLEANTECH ARCHITECTS

TOWARDS A CO_2-NEUTRAL HYDROGEN ECONOMY: SUMMARY

THESIS 01 The PATH towards competitive green hydrogen is LONGER and MORE COMPLEX than often suggested.

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THESIS 01

The PATH towards competitive green hydrogen is LONGER and MORE COMPLEX than often suggested.

THESIS

01

The PATH towards competitive green hydrogen is LONGER and MORE COMPLEX than often suggested.

*While **publications** and **funding programs** repeatedly assume **competitive production** of so-called 'green' hydrogen (i.e., hydrogen produced from renewable energy resources by means of electrolysis), we are looking at an entirely different reality today. More than **95%** of hydrogen used worldwide comes from the **category 'gray'** – and is produced from natural gas by steam reforming. The resulting climate effect is correspondingly high.*

*In terms of competitiveness, the production of the climate-friendly **green hydrogen variant** is still **far behind**: on average, green hydrogen **costs more than three times** as much as fossil-based, gray hydrogen.*

*Although **promising potentials along the value chain** of green hydrogen can be identified, it is currently not yet possible to achieve economic viability or sufficient market maturity, especially when it comes to production and distribution. Hence, a **steep learning curve** of various components of electrolysis systems coupled with continuously **falling electricity costs** is **required** to achieve cost-competitiveness with existing, gray hydrogen applications.*

STATUS QUO & IMPLICATIONS

Steep **LEARNING CURVE** of electrolysis systems required

Steady **EXPANSION** of **RENEWABLE ENERGIES** needed

THESIS

02

Economic battles that HYDROGEN CANNOT foreseeably WIN, must be deprioritized early enough.

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Economic battles that HYDROGEN CANNOT foreseeably WIN, must be deprioritized early enough.

*There are several application areas within both the **mobility** and the **building sectors** where hydrogen will foreseeably be **without real economic opportunities**. Other sustainable processes, especially direct electrification, often have an unbeatable advantage.*

*At the same time, there are many **initiatives** and **government-funded projects** that are still calling for hydrogen solutions to be developed in the areas of **car mobility** or **decentralized heat generation**. In fields that have no economic prospects, **fewer resources** should be invested in **publicly funded R&D**.*

*The **government should not present a wish-list**, but rather **use economic incentives** to **deploy funding more efficiently** as well as in a more targeted manner. After the development phase, a good indicator for any potential project is whether it succeeds in attracting significant private funds to co-finance public seed funding for a technology.*

STATUS QUO & IMPLICATIONS

BATTERY-powered cars: more **COST-EFFECTIVE** over shorter distances

Significantly **HIGHER EFFICIENCY** of **HEAT PUMP** applications

Focus on **INDUSTRIES** with **HIGH EMISSIONS** & few substitutes

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THESIS

03

The CARBON FOOTPRINT of hydrogen needs to be considered MORE REALISTICALLY and portrayed more transparently.

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03

The CARBON FOOTPRINT of hydrogen needs to be considered MORE REALISTICALLY and portrayed more transparently.

*The media too often portrays H2 – in all its colorful variations – in a clearly climate-neutral light. This is not the case. Especially the production of hydrogen via conventional processes from **natural gas entails a high climate impact** along the value chain.*

*This applies not only to the production via steam reforming, but also to the **transport** of the natural gas with its **high leakage rate of the greenhouse gas intensive methane**, which is difficult to monitor. It will therefore be important to **immediately reduce methane** and **carbon dioxide emissions** generated via gray processes on the one hand, as well as to **achieve a more accurate 'footprint'** along the value chain of the greenhouse gas emissions of hydrogen on the other.*

*Efforts to **achieve mutual agreements and standards** at the **European level** are extremely important. However, given the economic consequences this might have on entire industries, actors on the European level are also correspondingly affected by **lobbying activities**.*

STATUS QUO & IMPLICATIONS

~70% H2 from **ELECTROLYSIS** causes ~70% more CO_2 emissions than **GRAY** H2

at today's electricity mix in DE

Production of **BLUE** H2 will not achieve climate-neutrality[1]

CLIMATE-NEUTRAL production of green H2 requires rapid expansion of **RENEWABLES**

[1] In the medium term due to emissions during extraction and transport to CO_2 storage facilities

THESIS

04

GERMANY will NOT be able to produce its entire demand of green hydrogen DOMESTICALLY.

THESIS

04

Even in the long run, GERMANY will hardly be able to cover its own demand for green hydrogen from DOMESTICALLY produced renewable energy resources.

*Following the **shutdown of German nuclear power and coal**, Germany faces a major challenge in providing **sufficient renewable electricity**. The tightened climate protection targets and the welcome plan to supply sensible processes with green hydrogen in the future will make Germany more **dependent on imports** from the sun-rich countries of southern Europe and the MENA region.*

*At the same time, the production of hydrogen in these regions faces major **challenges** concerning the **transportation logistics.** According to the current state of development, long-distance transport of hydrogen will be too expensive for large parts of the planned applications.*

*The **conversion of gray hydrogen**, which is used in many areas today – from fertilizer production to the refinement of specialty chemicals – must be pursued as a top priority given the high climate effect of its processes. However, these **processes cannot simply be converted** to green hydrogen due to missing electrolysis capacities and high costs. Thus, a pragmatic solution for decarbonizing gray hydrogen must be found quickly. In a **transitional period**, it will **not be possible to refrain from the production of hydrogen from natural gas** in a more climate friendly way (e.g., blue hydrogen).*

STATUS QUO & IMPLICATIONS

+4% *every year* **ENERGY DEMAND** is expected to increase 4% every year until 2050

ENERGY IMPORTS from Polish **COAL-FIRED** or French **NUCLEAR** power plants imaginable[1]

Fast **EXPANSION** of transportation **INFRA-STRUCTURE** required

[1] During transitional period

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THESIS

05

Market participants that cannot COMPETE INTERNATIONALLY should avoid the field.

THESIS

05

Market participants that will not be able to compete within the INTERNATIONAL HYDROGEN MARKET due to their lack of size, risk-taking propensity or technology expertise should avoid the field.

***Subsidies** from both Germany and the EU **suggest low-risk investments** into a **growing market** for companies of all sizes. Looking at the international competition, this is not the case.*

*In the mid-term, those **companies and technologies** that receive the **largest and most targeted seed financing** and offer an internationally competitive product within an economically sensible hydrogen application field – driven by international competition of state subsidies – will be **successful.** These companies will also receive the highest amount of venture capital.*

*Consequently, the perspective in Germany must be much more **directed towards the creation of a global hydrogen market**. Moreover, to compete on an international level and be able to offer a competitive portfolio, a **critical size**, a **strategic approach** and **staying power** are required. Market participants that do not have these qualities take very high, possibly existential, risks when pursuing platform or infrastructure projects. They should therefore already **involve shareholders** at an early stage of their business development.*

STATUS QUO & IMPLICATIONS

$19bn
funding[1]

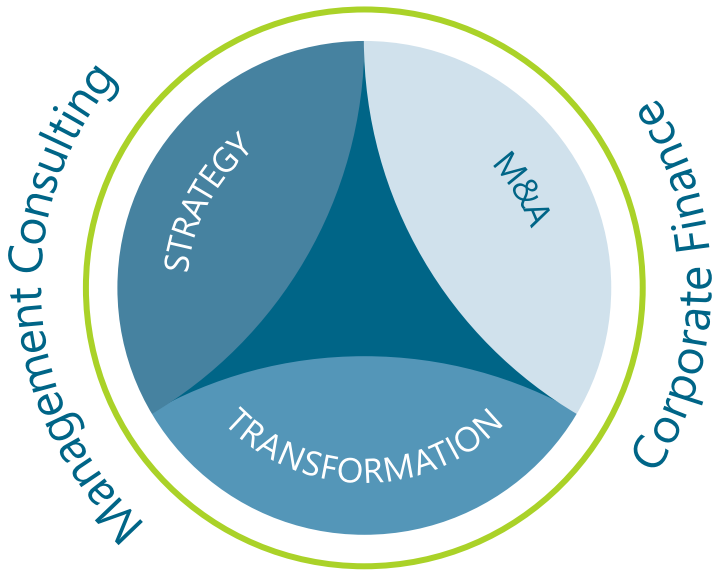
JAPAN as a **PIONEER** in terms of cooperation and government funding

More **INTERNATIONAL COOPERATION** and collaboration needed

Seed financing, risk capital and funding only for **PLAYERS** that can compete **GLOBALLY**

[1] As part of the national hydrogen strategy

About goetzpartners



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goetzpartners is an independent advisory firm for all key issues of entrepreneurial activity: strategy, M&A and transformation. This unique approach makes clients measurably more successful. The combination of corporate finance and management consulting creates sustainable added value when determining valid courses of action, reaching decisions and implementing them. Boasting a vast wealth of business experience, goetzpartners advises clients in all key industries world-wide: Industrials & Mobility, Technology, Media & Telecommunication, Infrastructure, Transportation & Energy, Financial Institutions, Pharma, Healthcare & Medtech, Retail & Fast Moving Consumer Goods and Business Services.

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Get in touch!

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