No-regret Hydrogen
无悔氢能

Charting early steps for H_2 infrastructure in Europe.
为欧洲氢基础设施制定早期行动计划

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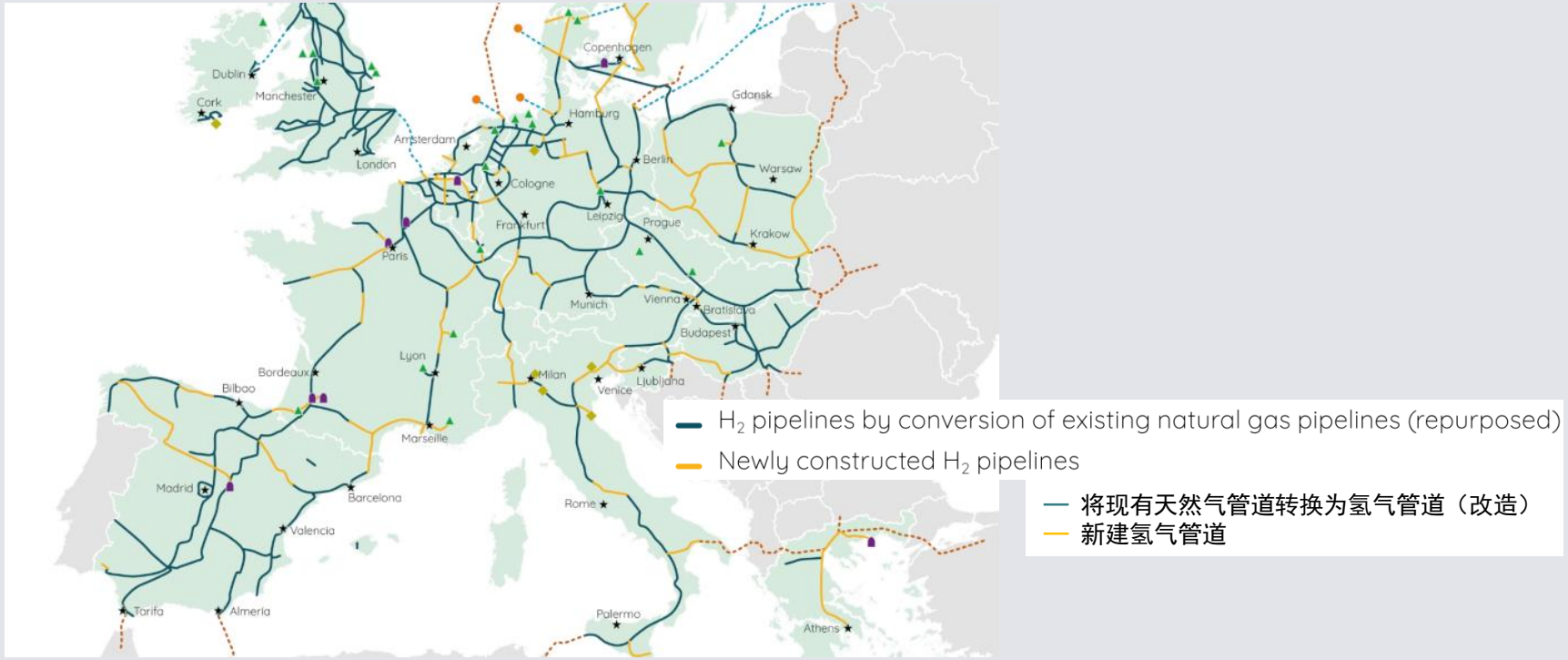
Agora Energy – Who we are
Agora能源转型论坛简介

- **Think tank** and **policy lab**
  智库和**政策实验室**
- Round about **100 energy transition experts**
  约**100位能源转型专家**
- **Independent** and non-partisan with diverse financing structure
  独立、无党派，具有多元化融资结构
- **Our vision** - A prosperous and **climate neutral global economy** by 2050
  我们的愿景——到2050年实现繁荣和**气候中和的全球经济**
- **Policy advice** to deliver **clean power, heat and industry** – in Germany, Europe and around the Globe
  提出**政策建议**，以推动德国、欧洲以及全球**清洁电力、供热和工业**的发展
- **Headquarter in Berlin**, with offices in Brussels, Beijing and Bangkok
  总部位于柏林，在布鲁塞尔、北京和曼谷设有办事处

Background 背景：
European gas TSOs propose to develop a hydrogen backbone.
欧洲天然气输送系统运营商提议建设氢气骨干网

European Hydrogen Backbone 2040　2040年欧洲氢气骨干网



Gas TSOs/Guidehouse 2021: Extending the European Hydrogen Backbone
Gas TSOs/Guidehouse 2021: 《延伸欧洲氢气主干网》

There is a limited set of no-regret applications in all sectors that need renewable hydrogen to become climate-neutral.
In this analysis, we focused on the industry part.
在所有需用可再生氢来实现气候中和的领域中，毫无异议应用氢能的场景十分有限。
在此分析中，我们重点关注工业领域的应用。

Green molecules needed? 需要绿色分子？	Industry 工业	Transport 运输	Power sector 电力	Buildings 建筑
No regret 无悔	· Reaction agents (DRI steel) · Feedstock (ammonia, chemicals)	· Long-haul aviation · Maritime shipping	· Long-term storage for variable renewable energy back-up	· Heating grids (residual heat load *)
Controversial 有争议	· High-temperature heat	· Trucks and buses ** · Short-haul aviation and shipping	· Absolute size of need given other flexibility and storage options	
Bad idea 不明智	· Low-temperature heat	· Cars · Light-duty vehicles		· Building-level heating

* After using renewable energy, ambient and waste heat as much as possible. Especially relevant for large existing district heating systems with high flow temperatures. Note that according to the UNFCCC Common Reporting Format, district heating is classified as being part of the power sector.

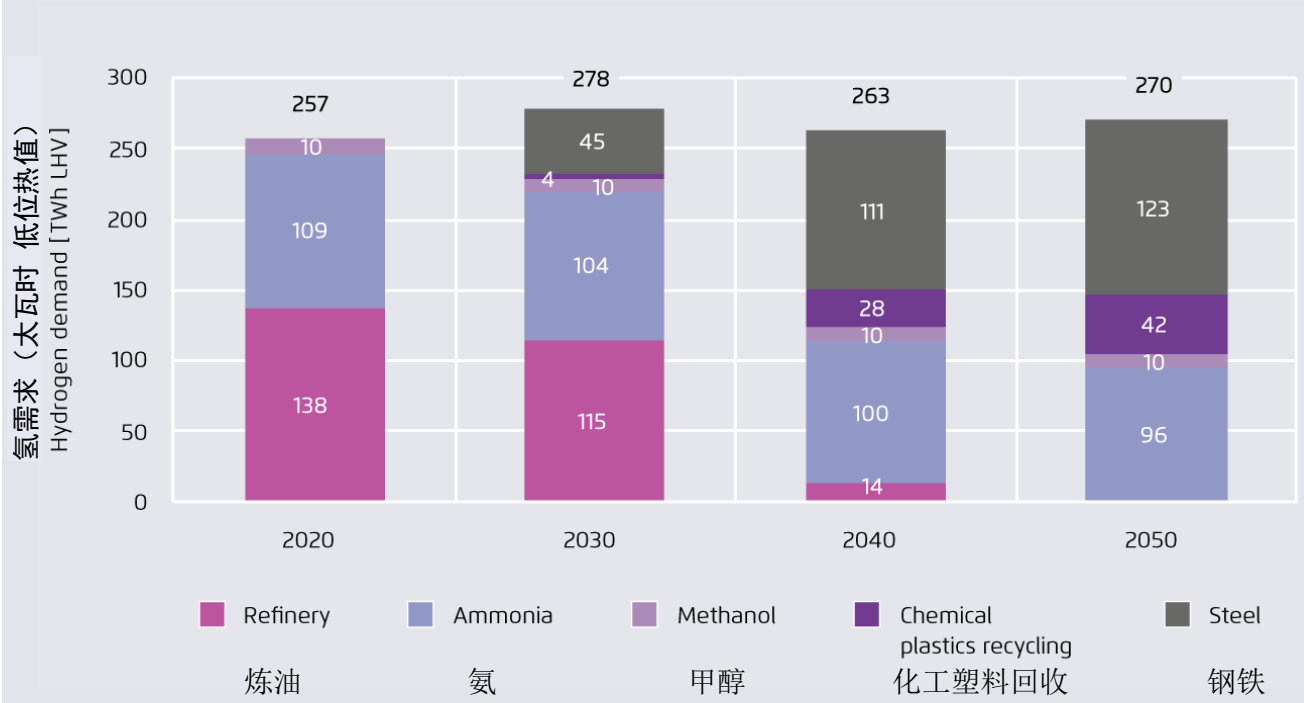
** Series production currently more advanced on electric than on hydrogen for heavy duty vehicles and busses. Hydrogen heavy duty to be deployed at this point in time only in locations with synergies (ports, industry clusters).

Agora Energiewende (2021)
Agora能源转型论坛（2021年）

* 在尽量使用可再生能源、环境热量和余热后，特别是与现有的具有高流动温度的大型区域供热系统相关时。请注意：根据《联合国气候变化框架公约通用报告格式》的规定，区域供热归属电力行业。
** 目前，电动重型车辆和公共汽车的系列化生产比氢动力的更先进。当前仅在具有协同效应的地点（港口、工业园区）部署重型氢动力车辆。

The no-regret industrial applications represent a major area of hydrogen demand in the future due to a lack of alternative decarbonization options.
由于缺乏替代的脱碳方案，无悔工业应用成为未来氢气需求的主要领域

Industrial hydrogen demand from 2020 to 2050 in TWh per year
2020年至2050年的工业氢需求，太瓦时/年



AFRY (2021)

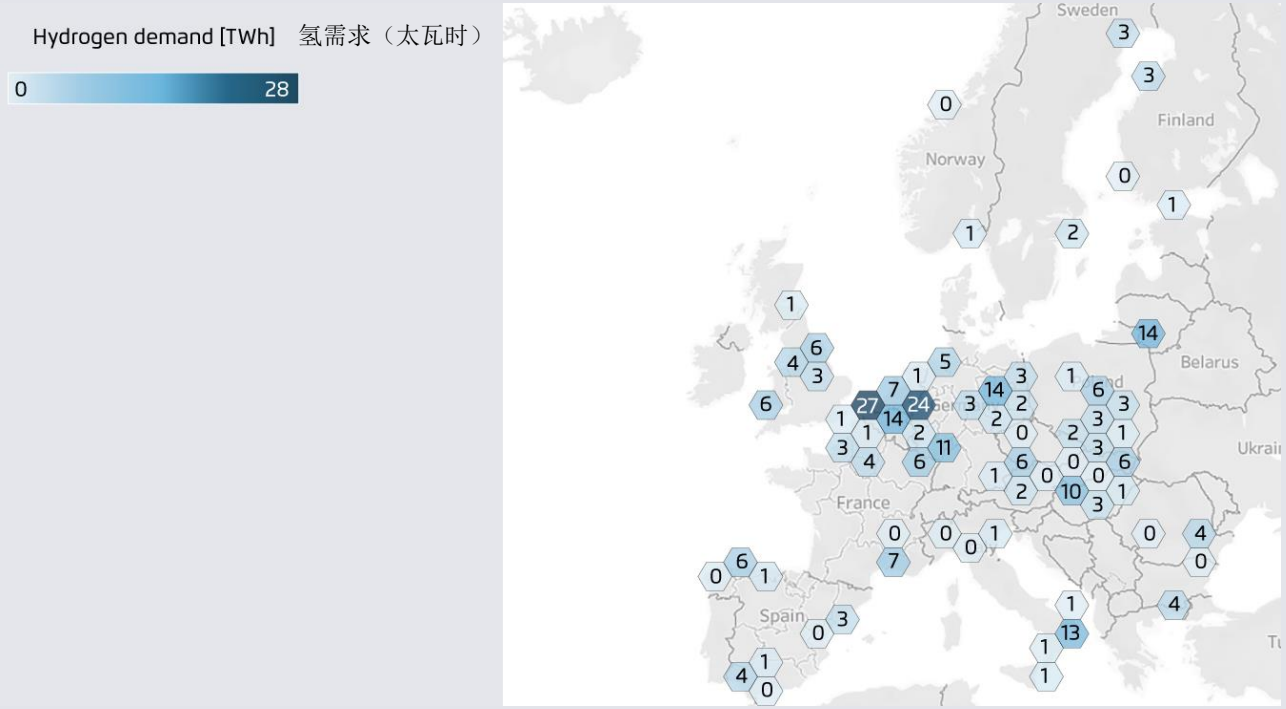
~300 TWh of low-carbon hydrogen will be required in Europe to reduce and eventually eliminate the process emissions from

欧洲将需要约合**300太瓦时**的低碳氢能，以减少并最终消除以下行业中的过程碳排放

- ammonia 氨
- Methanol 甲醇
- iron ore reduction 铁矿石还原
- petrochemicals for plastics and fuels
  生产塑料和燃料的石化产品
- plastics recycling
  塑料回收

Steel, ammonia, refineries and chemical plants are widely distributed across Europe.
钢铁、合成氨、炼油厂和化工厂广泛分布在欧洲各地

Industrial hydrogen demand projected for 2050 in TWh per year
2050年工业氢需求预测，太瓦时/年



AFRY (2021). 2050 demand is mainly driven by ammonia and steel production.
AFRY (2021). 2050年需求主要由氨和钢铁生产驱动。

- Demand differs by more than an **order of magnitude**:

  < 1 TWh vs. 10-30 TWh

  地域需求差异**巨大**：

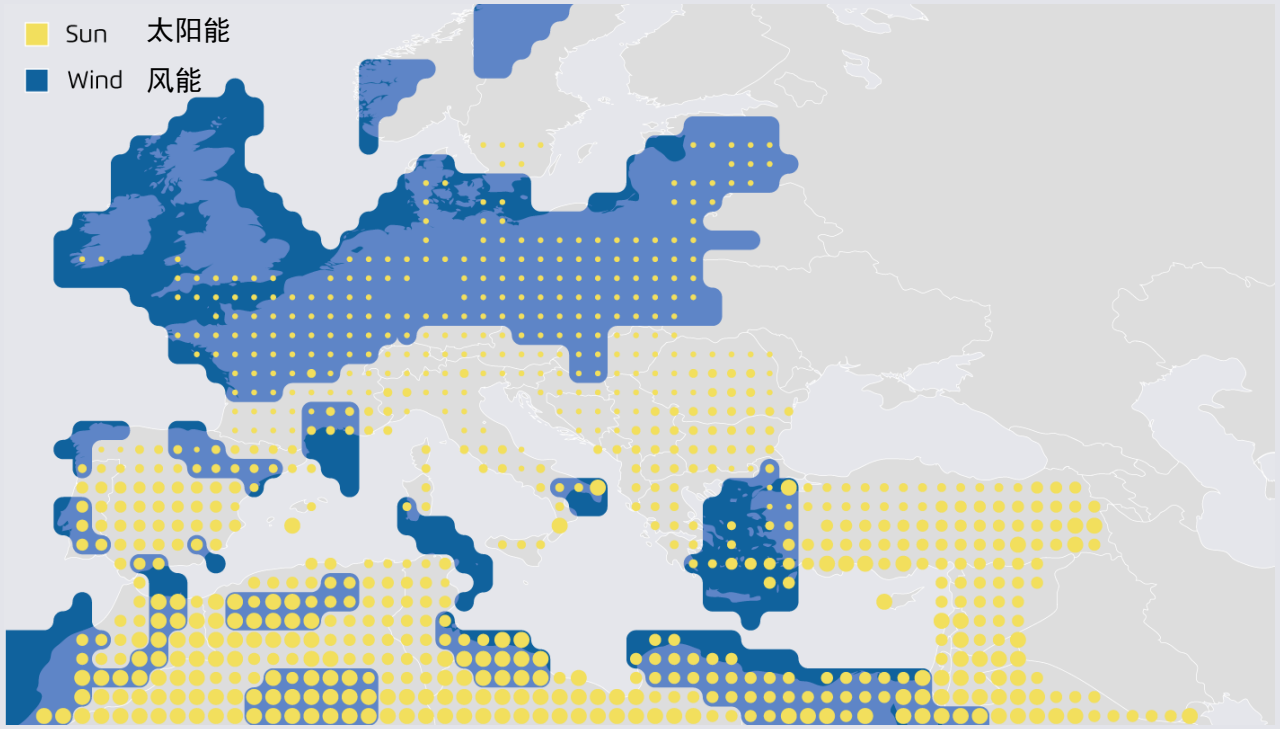
  有的低于1太瓦时，有的在10–30太瓦时

- **High demand** for hydrogen 氢能**高需求**地区
  - in Belgium, the Netherlands, Germany with large cluster of chemical installations and steel plants

    拥有大量化工设施和钢厂的比利时、荷兰和德国
  - in Eastern Europe 东欧
  - and along the Mediterranean 地中海沿岸

European and neighbouring countries have a high renewable energy potential that can be tapped for direct-electric applications and renewable hydrogen production.
欧洲及其邻国的可再生能源潜力很大，可开发用于直接电气应用和氢气生产

Solar and wind potential in Europe and the MENA region
欧洲和中东及北非地区的太阳能和风能潜力



Dii & Fraunhofer-ISI (2012)

Renewable energy sources 可再生能源

- → Central-North Europe: Wind 中欧-北欧：风能
- → South Europe: Solar PV 南欧：太阳能光伏
- → Parts of MENA: hybrid solar and wind
  中东和北非地区：太阳能和风能混合能源

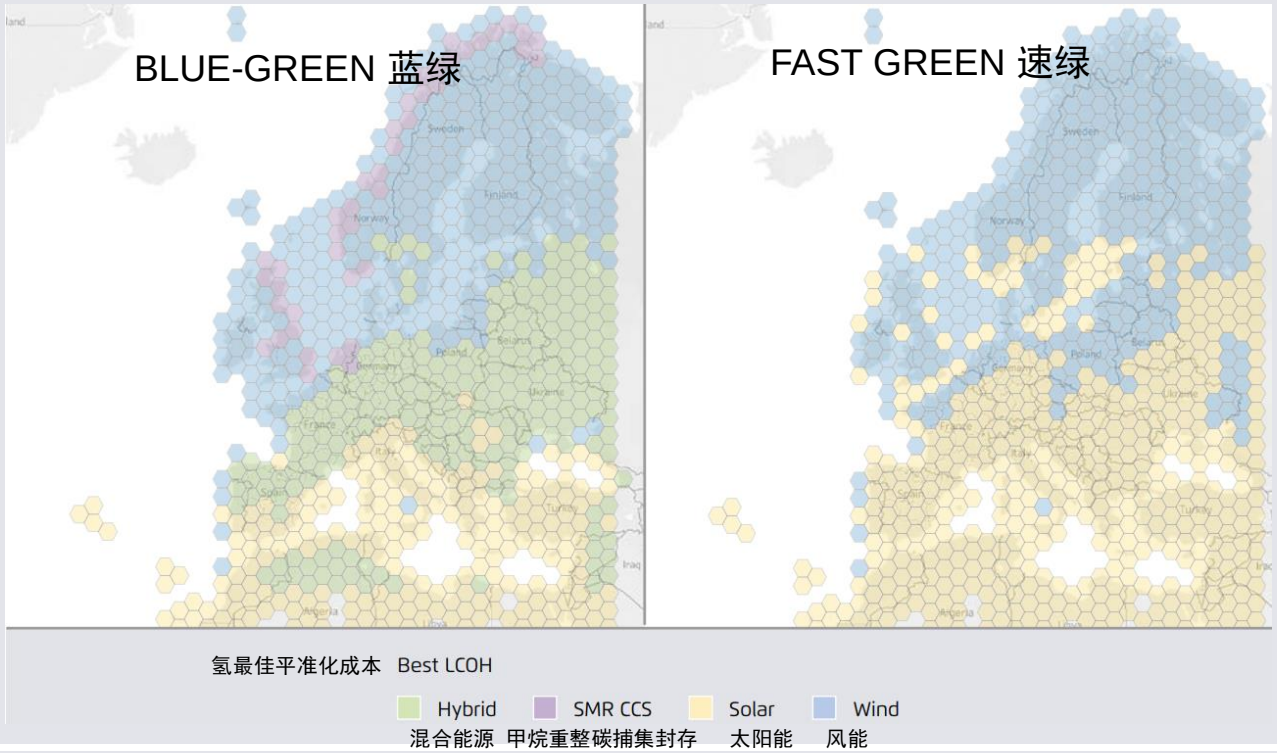
Two scenarios in this study 本研究包含**两种情况**

- → BLUE-GREEN: renewable H_2 and H_2 from SMRCCS in NL, NO, UK
  蓝绿：荷兰、挪威和英国的可再生氢和由甲烷蒸汽重整+碳捕集封存制取的氢
- → FAST GREEN: no SMRCCS; assumes aggressive reduction in electrolyser costs, in line with targets set by the EU hydrogen strategy.
  速绿：无甲烷蒸汽重整+碳捕集封存；假设电解槽成本大幅降低，与欧盟氢能战略目标一致。

The investment window for fossil-based hydrogen with carbon capture remains open, but in the long run renewable hydrogen will emerge as the most competitive option in Europe.

配备碳捕集技术的化石来源制氢项目仍具投资可行性，但长远来看，可再生氢将成为欧洲最具竞争力的制氢路径

Best levelised costs of hydrogen in the two scenarios for 2030
2030年两种情况下氢的最佳平准化成本



- In the BLUE-GREEN scenario, fossil-based hydrogen with carbon capture will remain a **viable investment until the 2030s**.

  在蓝绿情形下，配备碳捕集技术的化石来源制氢**直到2030年代仍是可行的投资选项**。

- However, strong policies for renewable hydrogen will **shorten the investment window for fossil** hydrogen, likely closing it by the end of the 2020s.

  然而，强力支持可再生氢的政策将**缩短化石制氢的投资窗口**，很可能使其在2020年代末关闭。

- **Ambitious policy will be needed** to drive down the cost of renewable hydrogen.

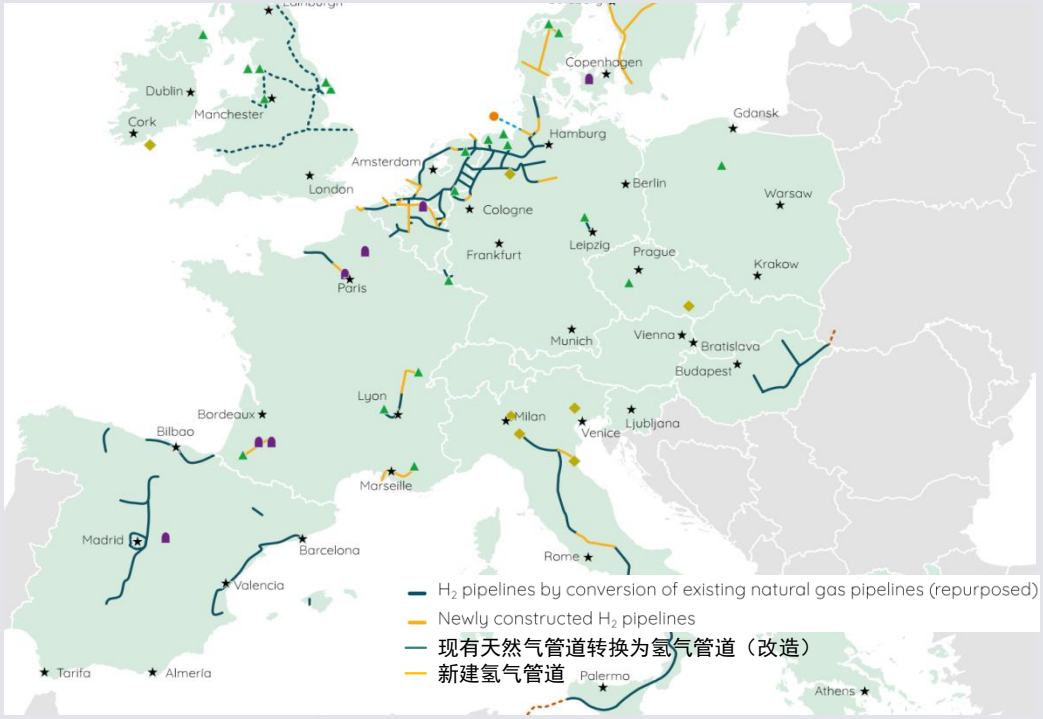
  需要采用更具雄心的政策来降低可再生氢的生产成本。

AFRY (2021)

Hybrids use both solar PV and wind. In the BLUE-GREEN scenario, SMR CCS is restricted to the Netherlands, the UK and Norway.
混合能源同时使用太阳能光伏和风能。在蓝绿情形下，甲烷重整碳捕集封存制氢仅限于荷兰、英国和挪威。

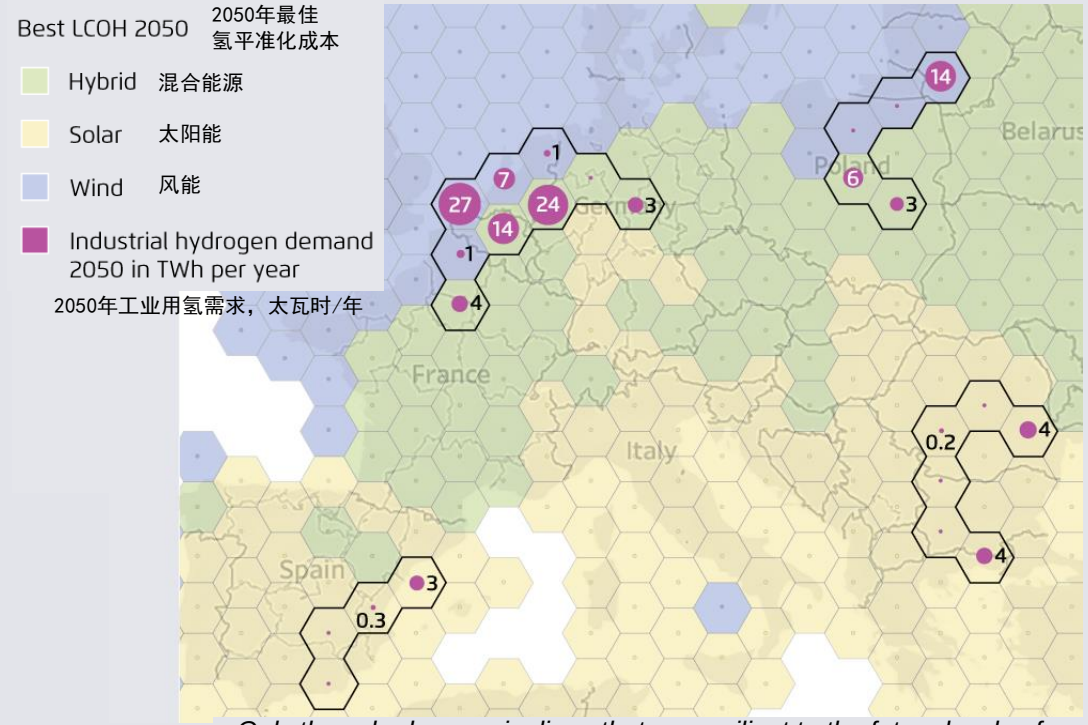
Hydrogen infrastructure: Where to start?
No-regret investment opportunities 2030 for hydrogen pipelines, based on industrial demand.
氢基础设施：始于何处？基于工业需求的2030年氢气管道无悔投资机会

European Hydrogen Backbone 2030　　2030年欧洲氢气主干网



Gas TSOs/Guidehouse 2021

No-regret corridors for 2030 based on industrial hydrogen demand
基于工业氢需求的2030年无悔走廊



AFRY 2021

Only those hydrogen pipelines that are resilient to the future levels of hydrogen demand and the technology assumptions used here have been considered to be "no-regret".
只有适应未来氢气需求水平和此处技术假设的氢气管道才被称为“无悔”。

Key conclusions 主要结论

1	Hard-to-abate industrial sectors represent a major area of hydrogen demand in the future due to a lack of alternative decarbonization options. 难减排的工业部门由于缺乏替代的脱碳路径而成为未来用氢的主要领域。
2	The investment window for fossil-based hydrogen with carbon capture remains open, but in the long run renewable hydrogen will emerge as the most competitive option across Europe. 配备碳捕集技术的化石来源制氢仍具投资可行性，但长远来看，可再生氢将成为全欧洲最具竞争力的制氢路径。
3	We identify robust no-regret corridors for early hydrogen pipelines based on industrial demand. 我们根据工业需求为早期氢气管道设计了无悔骨干走廊。

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Thank you for your attention!

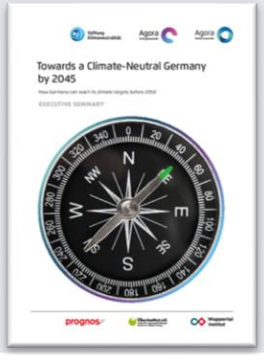
感谢各位的聆听！

Questions or Comments? Feel free to contact me:
如有任何问题或建议，请随时与我联系：

matthias.deutsch@agora-energiewende.de

Ma_Deutsch

Publications on climate-neutrality, hydrogen and industry
关于气候中和、氢和行业的出版物

Making renewable hydrogen cost-competitive 让可再生氢具有成本竞争力	No-regret hydrogen: Charting early steps for H_2 infrastructure in Europe 无悔氢：为欧洲氢基础设施制定早期行动计划	Towards a climate-neutral Germany by 2045 走向2045年气候中和的德国	Breakthrough Strategies for Climate-Neutral Industry in Europe 欧洲气候中和产业的突破性战略	The Future Cost of Electricity-Based Synthetic Fuels 电力合成燃料的未来成本
				
> main study 主要内容 > legal analysis 法律分析	➢full study 全文	> summary (EN) 摘要（英语） > full study (DE) 全文（德语）	> summary 摘要 > full study 全文	> full study 全文 > PtG/PtL calculator PtG/PtL计算器
> slide deck 幻灯片 > webinar 在线研讨会	> data appendix 资料附录 > webinar 在线研讨会	> data appendix (DE) 资料附录（德语）	> Webinars 在线研讨会	> slide deck 幻灯片 > webinar 在线研讨会