

DOCKET

09-ALT-1

DATE 9/29/2009

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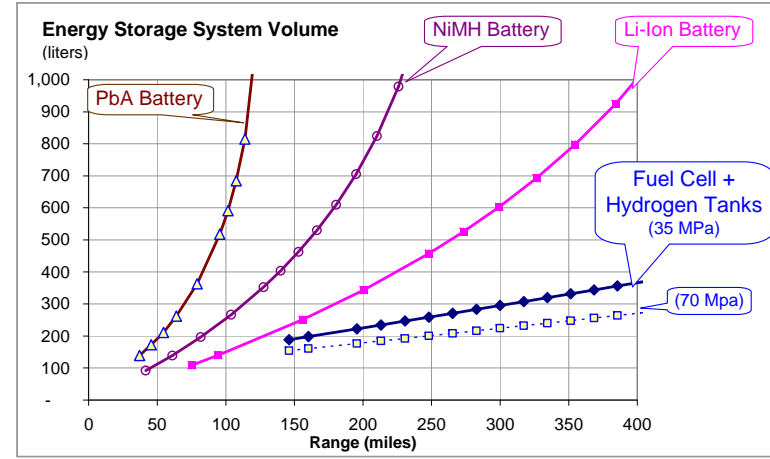
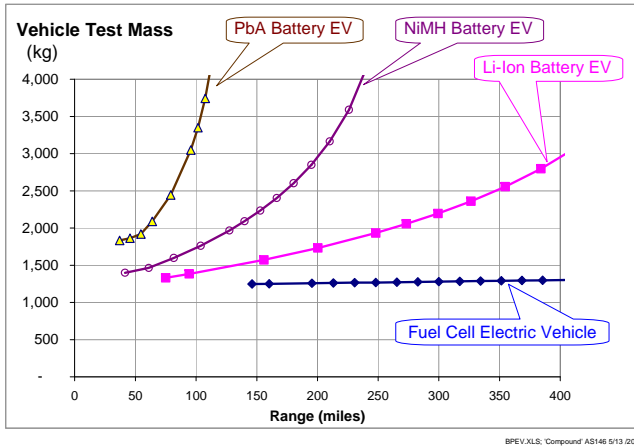
Linde Comments to CEC

29 September 2009

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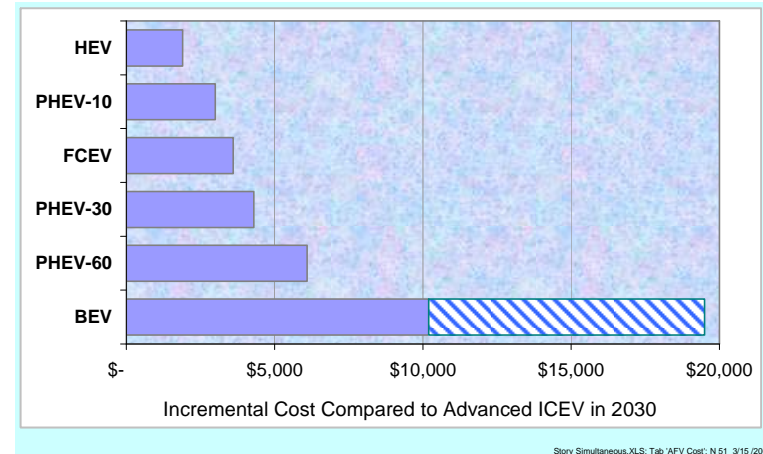
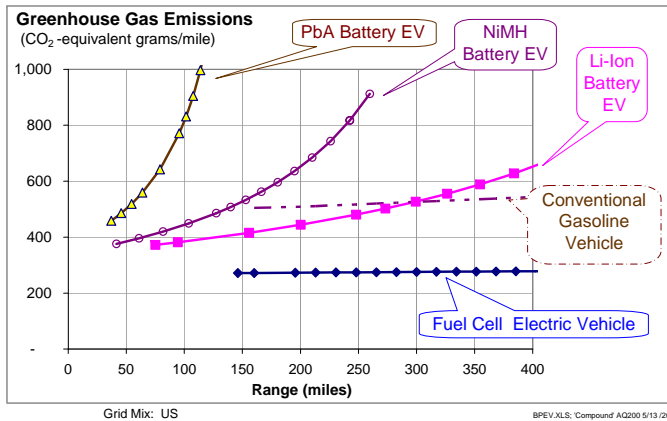
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There are some advantages to hydrogen fuel cell vehicles



Batteries weigh more

Batteries take up more space



Batteries are poor at GHG reduction

Batteries cost more

Advances in Infrastructure -- Linde perspective

- Release A refueling
- Ionic technology
- Product Portfolio
- Cost reduction

Advances in Infrastructure Release A Refueling

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GM Dudenhofen, Germany



- 240 Nm³/h,
1,200 Nm³/h in booster mode
- In operation since 05/2008
- Number of refuelings: 6,000

TOTAL Berlin, Germany



- 240 Nm³/h,
1,200 Nm³/h in booster mode
- In operation since 10/2008
- Number of refuelings: 350

OMV Stuttgart, Germany



- 280 Nm³/h,
2,400 Nm³/h in booster mode
- Initial commissioning 05/2009
- Station Opening 06/2009

Advances in Infrastructure - Ionic Technology for the material handling market (250 and 350 bar)

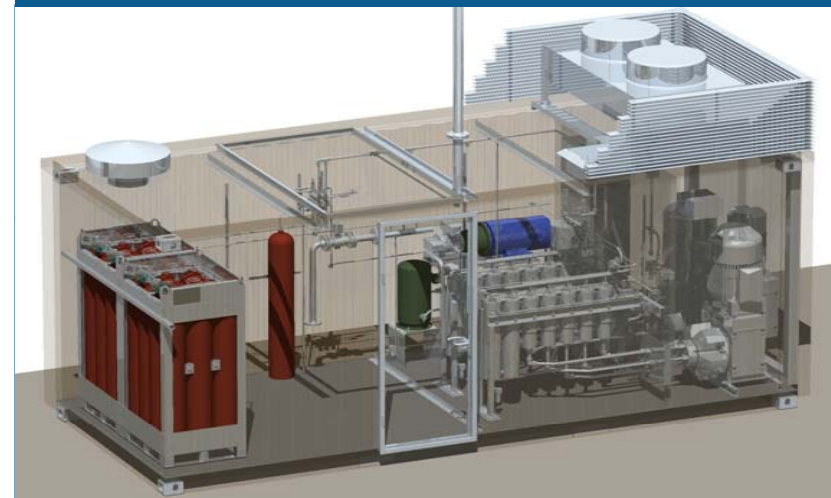
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Ionic Compressors – Basic facts

- **Works like** conventional piston compressor
- Solid piston is **replaced** by ionic liquid
- **Advantages:**
 - Nearly 100% **volumetric efficiency**
 - Nearly **isothermal** compression
 - **Contamination free** gas compression
 - Abrasion **free**
 - **Excellent conversion** of electrical energy into compression work
 - Perfectly **gas tight** system
- The compressor provides:
 - (i) **low energy** consumption and
 - (ii) high **durability**
- **H2 compression of up to 900 bar**

Product example: Ionic Fueler 42 FLT

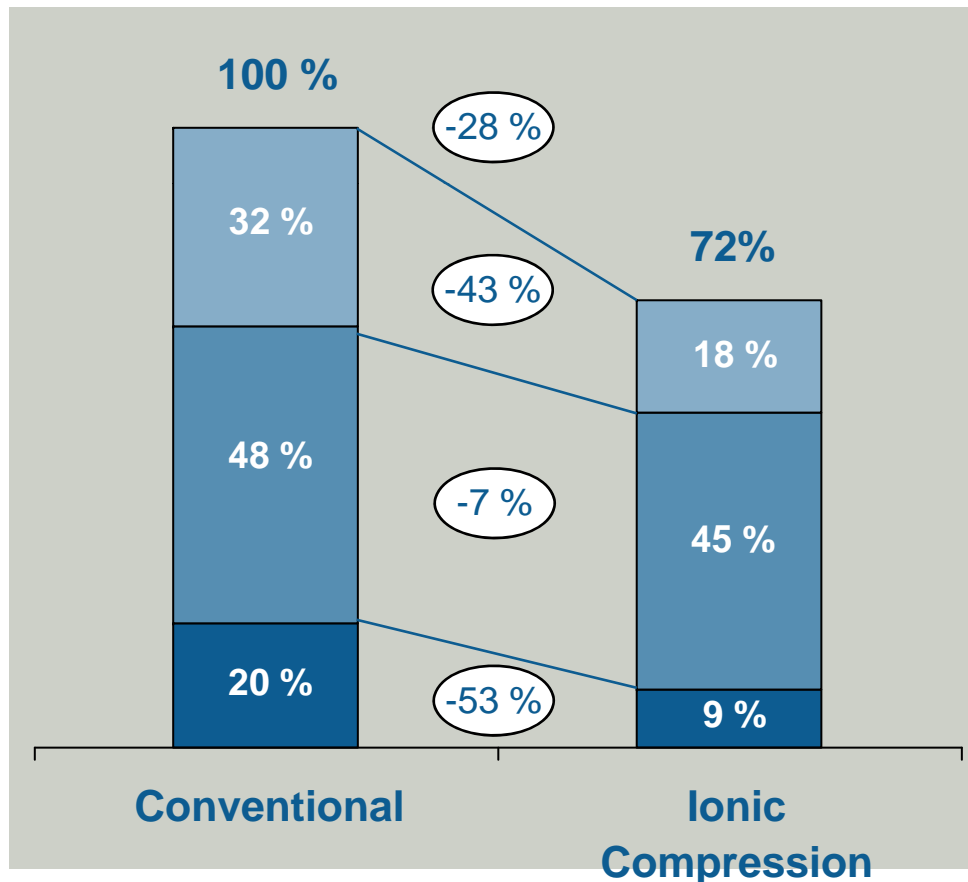
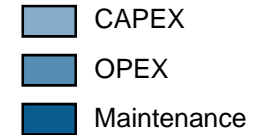


- **250 or 350 bar**
- Continuous fast fueling with **20 kg/h**,
in **booster mode up to 70 kg/h**

Advances in Infrastructure - Reduction of capital equipment and operating costs



Example – Ionic Fueler



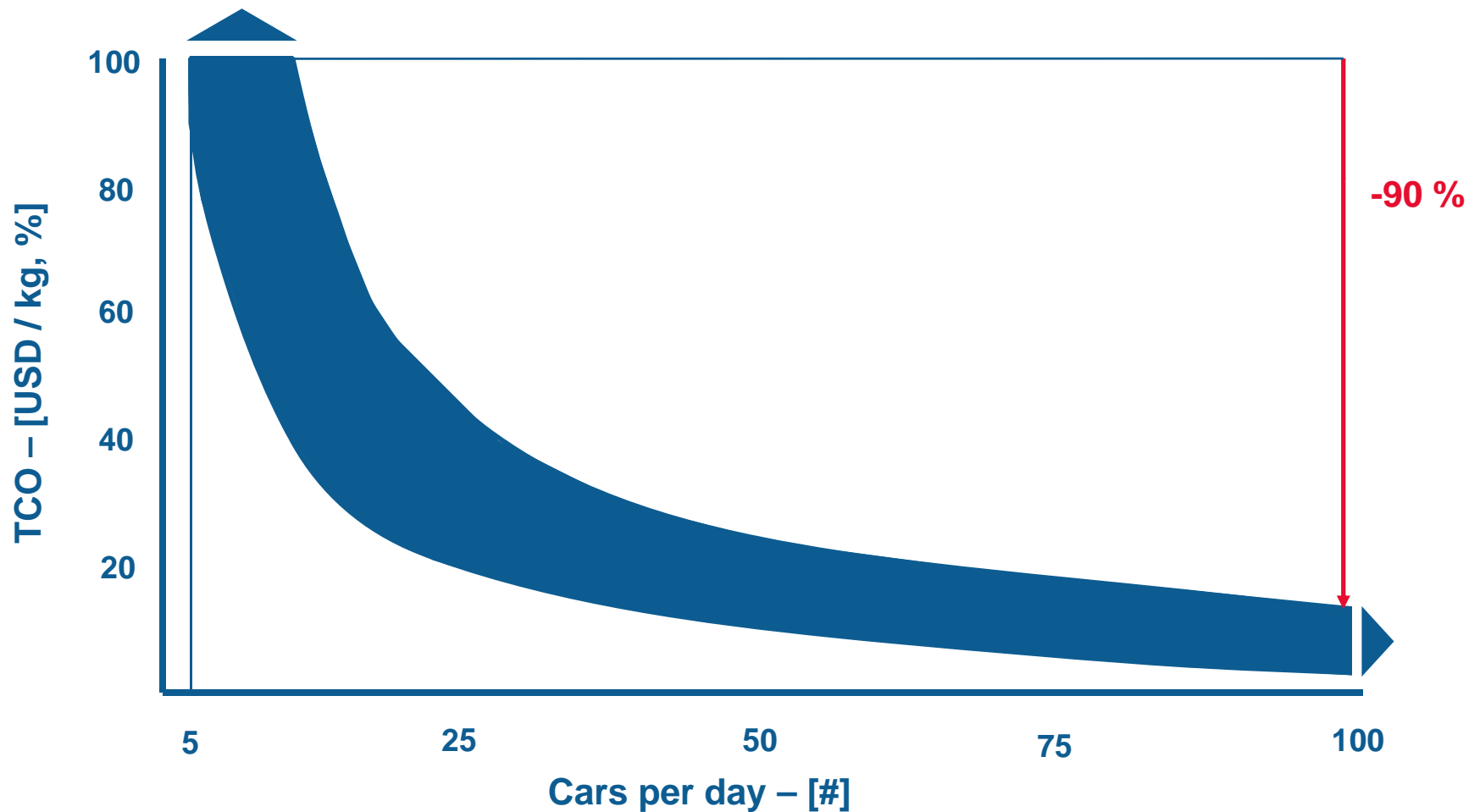
- **lower** investment costs
- **better** efficiency
- **larger** maintenance intervals lead to **better economics** of ionic compressor system

Advances in Infrastructure Cost Reduction

Focus – TCO of 700 bar
technology

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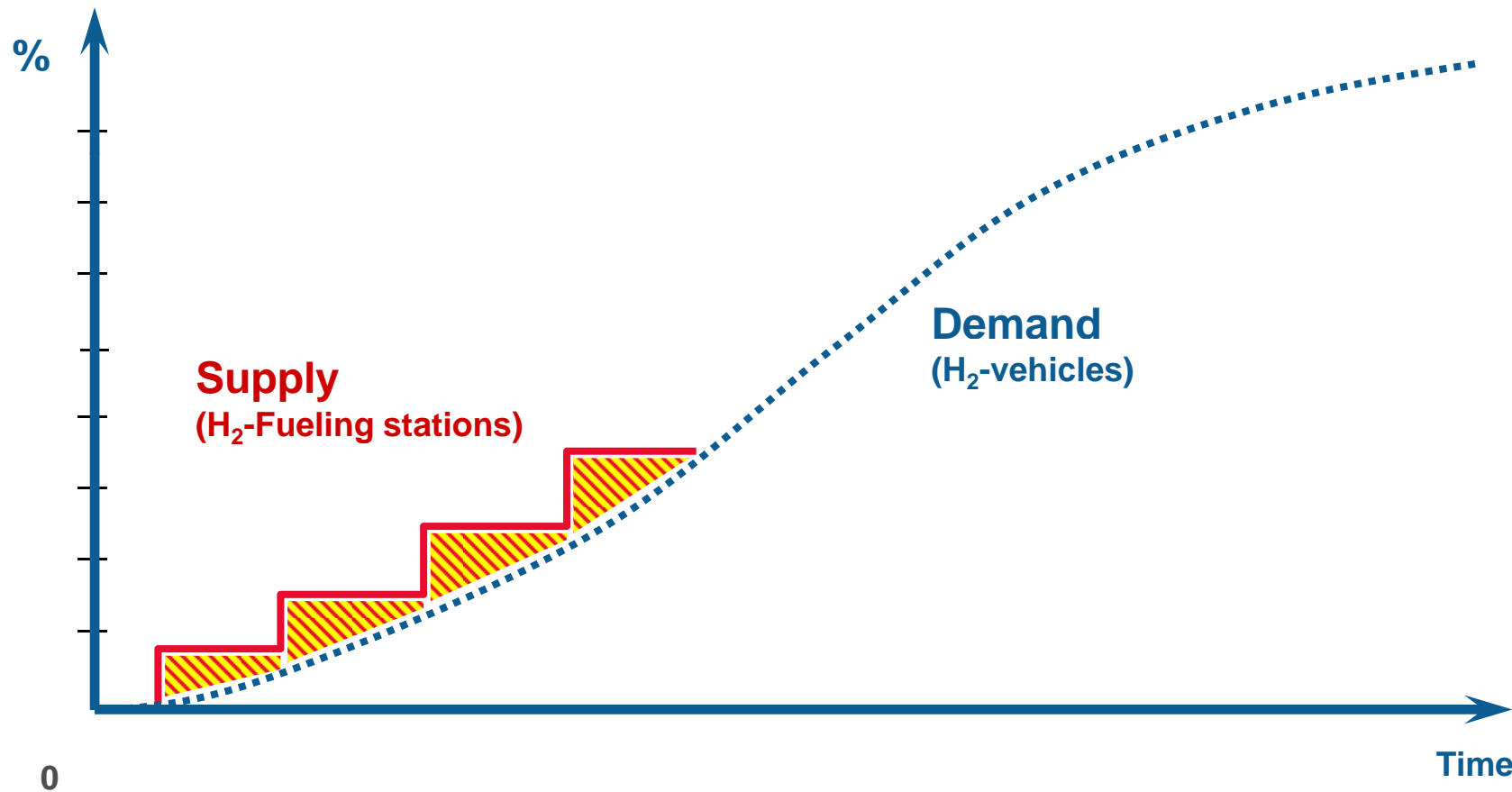
Critical Next Steps

Large Scale Infrastructure and Industrial Production?

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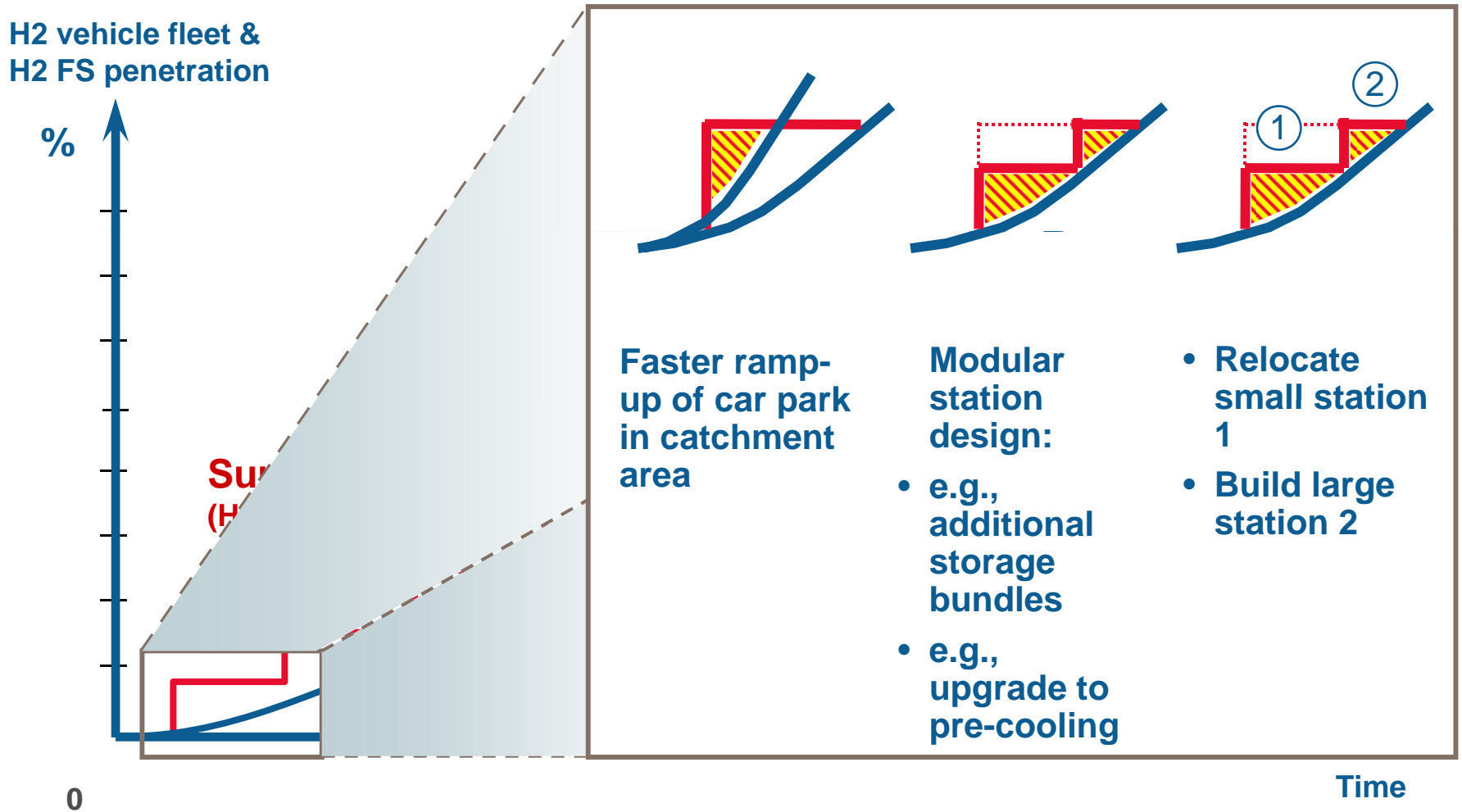
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H2 vehicle fleet &
H2 FS penetration



Critical Next Steps

There's more than one way to minimize the "loss making steps" ...



Commercialization will be reached through Government – Industry Partnership



- **Deployment of retail stations have some challenges...these can be overcome**
- **Over the next several years, with additional station deployments equipment providers will continue to improve efficiency and reduce cost**
- **Government support is critical to achieving profitable commercialization**