

## CONTENTS

About the author .....	1
Contents .....	2
Executive Summary .....	4
Introduction .....	7
<b>1. The Bipartisan Infrastructure Law is a game changer for clean hydrogen .....</b>	<b>8</b>
1.1 Policy developments are a turning point for hydrogen .....	8
1.2 The BIL lays the foundations for an ambitious clean hydrogen strategy and invests billions in clean hydrogen .....	9
1.2.1 Clean hydrogen: “Technology push” through RD&D and deployment.....	9
▪ A technology-neutral approach: clean H <sub>2</sub> ≤ 2 kgCO <sub>2e</sub> /kgH <sub>2</sub> .....	10
▪ RD&D and deployment: a pillar of the new hydrogen program.....	10
▪ Regional clean hydrogen hubs: at least four hubs to efficiently scale up demand .....	11
▪ Clean hydrogen electrolysis program: production cost under \$2/kgH <sub>2</sub> by 2026 .....	12
▪ Equipment manufacturing: creating a domestic manufacturing and supply chain.....	12
▪ National clean hydrogen strategy and roadmap to be published by 15 May 2022 .....	13
▪ Cooperation between national laboratories: NETL as the national coordinator .....	13
1.2.2 The BIL also invests billions in CCUS .....	13
1.3 The BBB Act’s tax credits for clean hydrogen and CCUS .....	15
1.3.1 The clean hydrogen tax credits would complement the BIL with a strong “market pull” .	15
1.3.2 The increased 45Q tax credit would provide significant support to CCUS .....	17
1.4 Green procurement policy .....	20
1.5. DOE hydrogen program: from R&D to deployment at scale.....	21
1.5.1 A strong hydrogen research program and funding.....	21
1.5.2 Major recent DOE clean hydrogen initiatives: H2 Shot and H2 MatchMaker .....	22
1.5.3 Regional clean hydrogen hubs: competition is heating up.....	23
<b>2. Domestic market development: A huge potential .....</b>	<b>27</b>
2.1 Current hydrogen demand: 13% of global demand.....	27
2.2 Future clean hydrogen demand: 60 MtH <sub>2</sub> /y, or even more by 2050.....	27
2.3 Feedstock for industry.....	29
2.3.1 Refining and chemical industry: the greatest near-term opportunity.....	29
2.3.2 Iron and steel industry: several alternatives in competition .....	31
2.4 Transport sector .....	33
Road transportation: heavy trucking the most promising segment for FCEVs development ...	33
Rail transport.....	36
Shipping.....	36
Aviation .....	37
2.5 Injection of hydrogen into natural gas pipelines.....	38
2.6 Power sector.....	41
2.6.1 Over 20 GW of existing and new capacity plan to burn hydrogen/natural gas blend.....	41
2.6.2 Energy storage: massive storage capacity under development .....	43
2.6.3 Distributed power generation: off-grid and backup power.....	46
<b>3. Hydrogen production: the US has a vast potential for all production pathways .....</b>	<b>47</b>
3.1 Current production: The US is the world’s second largest producer, behind China.....	47
3.2 Hydrogen: The energy carrier that unites all US energy resources and regions.....	47
3.3 Cost, scale, emissions, and delivery challenges .....	49
3.3.1 Costs: DOE’s hydrogen shot: \$1 per 1 kilogram in 1 decade .....	49
3.3.2 Scale and timing .....	51
3.3.3 GHG emissions of clean hydrogen over the life cycle and methane emissions.....	51
3.3.4 Delivery challenges .....	53

3.4 Big plans for blue hydrogen and ammonia .....	55
3.4.1 The deployment of blue hydrogen projects is taking off .....	55
3.4.2 Blue and turquoise hydrogen production to reach close to 2 MtH <sub>2</sub> /y by 2026.....	57
3.5 Green hydrogen production: first giga-scale projects.....	58
3.5.1 Power-to-X: a rapid catch up .....	58
3.5.2 First giga-scale projects announced .....	63
3.5.3 Biomass-to-hydrogen: testing new technologies .....	66
3.5.4 Green hydrogen production to reach around 1 MtH <sub>2</sub> /y by 2030 .....	66
3.6 A huge clean hydrogen production potential by 2030.....	67
3.7 Towards a leading position in export of clean hydrogen and hydrogen-based fuels .....	67
<b>Conclusion .....</b>	<b>71</b>
<b>Annex 1: Focus on key regional hubs.....</b>	<b>72</b>
<b>Annex 2: Blue and turquoise hydrogen projects in the US.....</b>	<b>78</b>
<b>Annex 3: Power-to-X projects in the US (electrolyzers) .....</b>	<b>83</b>
<b>Annex 4: Biomass-to-hydrogen projects in the US .....</b>	<b>85</b>
<b>Main Abbreviations.....</b>	<b>86</b>
<b>List of Tables, Figures, Maps and Boxes .....</b>	<b>88</b>