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REWIRE

Implementation Assessment and Roadmap – Report

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Commercial in Confidence

SYSTEMS · ENGINEERING · TECHNOLOGY

Implementation Assessment and Roadmap

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Overview



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Overview

- REWIRE's exploration of multi-vector energy systems looks at how implementing localised storage solutions enhance the energy system's ability to limit the extent, severity and duration of disrupted supply.
- Work Package 1 explored the suitability of domestic hydrogen storage and vector conversion technologies whilst Work Package 2 analysed which network archetypes would have greatest benefit from deployment of REWIRE. Work Package 3 provided a high-level cost-benefit analysis.
- This report will focus on assessing the feasibility of REWIRE adaptation by investigating the risks, opportunities and potential blockers to implementation from the domestic and network perspective.
- A road mapping exercise was undertaken to define technical and commercial factors that will impact the future development and implementation of REWIRE technology.

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STEEPLE Analysis

A widely-used planning tool for analysing market strategies considering the following factors:

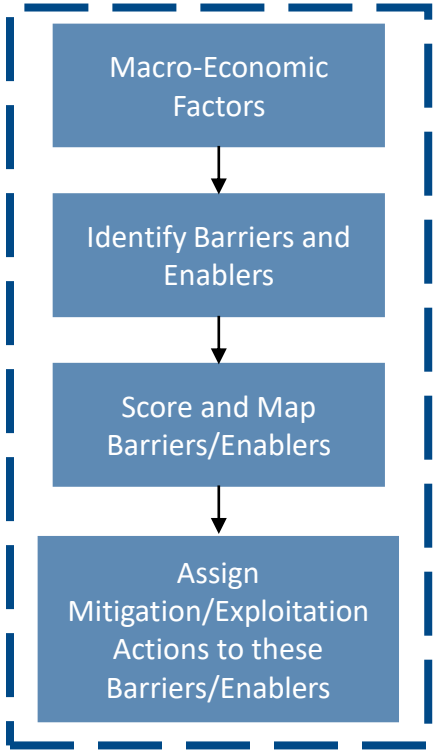
- Social
- Technological
- Economic
- Environmental
- Political
- Legal
- Ethical



STEEPLE Analysis

STEEPLE analysis is widely-used planning tool for analysing market strategies, it considers 7 macro-environmental external factors and provides a detailed overview for each field; this technique is used to form a list of the barriers and enablers for route to market provided on the following slides.

Initial	Definition	Description
S	Social	Cultural changes and market research considerations, involving the demographic and current trends and patterns.
T	Technological	Advancement of technologies and capitalising on changes; considering factors such as rate of change, automation and research and development.
E	Economic	Economic situation presently and in the future; considering inflation, employment rates, international trade and rate of growth.
E	Environmental	The impact on the environment and considering how the environment will impact the cost of green energy.
P	Political	Factors including political situation, stability, trade agreements, government sanctions, and subsidies.
L	Legal	Regulations and laws which will impact the market strategy.
E	Ethical	Considers morality, integrity, behaviour and how these will be impacted by a strategy.



STEEPLE Analysis Process

STEEPLE Analysis

ID	Summary	Description	Mitigating/Exploiting Action(s)	STEEPLE Factor(s)	Barrier/Enabler
1	Maximising Renewable Energy	**Maximises the use of renewable energy supplies.** A major problem with exploiting renewable energy is intermittency, which makes matching supply and demand difficult in real-time. A suitable means of storage would solve this; for example, using solar to produce hydrogen in the day (or during summer) for use overnight (or during winter).	To undertake research on areas where there has been low uptake of renewable domestic energy sources and would benefit from their installation. Subsequently, target communication about REWIRE's capabilities and advantages to potential customers in the identified areas.	Environmental Technological Economic	Enabler
2	Investment Cost Decreasing	From research, there are a few integrated hydrogen energy storage systems (with fuel cells and electrolysers). As these companies mature, the technology develops and market uptake increases **the cost of investment will decrease.**	The following actions will ensure that REWIRE remains a competitive, viable option: • Keep up to date with technological research and aim to utilise new technology (developments in electrolysers, fuel cells and hydrogen storage options) • Establish connections with relevant technology developers	Economic Technological	Enabler
3	Decentralised Grid Transition	There is a **push towards distributed generation in the UK and a decentralised grid in some regions.** REWIRE aims to increase grid resilience by supporting this transition as a way of meeting changing energy demands of the future.	Advertise the benefit of REWIRE and engage with stakeholders to ensure smooth transition and keep up to date with potential funding opportunities.	Economic Technological	Enabler

STEEPLE Analysis

ID	Summary	Description	Mitigating/Exploiting Action(s)	STEEPLE Factor(s)	Barrier/Enabler
4	Consumer Bill Reduction	Behind the meter systems would lead to a **decrease in energy costs for consumers** as they are independent of the grid. There are also tariffs to **sell surplus energy back to the grid** which is added incentive for consumers.	Raise public awareness of the benefits REWIRE can give to the consumers such as increased power resilience and decreased energy costs.	Social Economic	Enabler
5	Distribution Network Operator (DNO) Fine Reduction and Costs	REWIRE increases resilience for consumers as they would become more grid independent meaning that during power outages, customers could access an alternative supply. If the technology is partly funded by DNOs, this could **help reduce Ofgem fines** if outages were to occur. Also, increasing availability of flexible resources mitigates the need for costly reinforcements.	This added benefit to distribution networks may motivate incentive/subsidy schemes to help customers invest in the technology.	Economic Legal	Enabler
6	Gas/Electricity Optionality	REWIRE could give homeowners the **opportunity to choose heating their home with the generated hydrogen directly, through a boiler** (or hybrid heat pump) compared to only being able to select electric heating technologies in the future.	Raise public awareness of additional optionality provided by REWIRE to encourage uptake by customers.	Social	Enabler

STEEPLE Analysis

ID	Summary	Description	Mitigating/Exploiting Action(s)	STEEPLE Factor(s)	Barrier/Enabler
7	Supporting Isolated/Vulnerable Customers	Many distribution network operators have a responsibility and strategy to **support isolated and vulnerable customers.** The capability for REWIRE to be used in remote locations and improve resilience by readily storing renewable energy helps to achieve these aims.	Advertise REWIRE's potential benefits in these circumstances and communicate closely with such demographics. REWIRE technology could possibly be supplied to vulnerable residents by DNOs to provide resilience.	Technological Social Ethical	Enabler
8	Grid Balancing Mechanisms	**Grid balancing approaches supplied by the technology,** such as frequency response, voltage control, demand side response and reactive power compensation encourage grid resilience, allowing for a more flexible grid.	Emphasise the benefits of REWIRE towards a resilient and flexible grid, especially in the face of increasing extreme events – both from climate change and from manmade hazards such as war.	Social Technological Economic Environmental	Enabler
9	Positive Public Perception	**Public perception** of REWIRE technology may be **positive** as it offers both **added resilience and a shift away from fossil fuel generated energy** which benefits the environment.	Use public opinion surveys and engagement to identify potential customers for REWIRE demonstration projects.	Social Environmental Ethical	Enabler
10	Overseas Large-scale Deployments	**Used at MW scale in Japan and the US** to supply energy to larger occupancy building, such as office blocks etc, meaning that REWIRE developments could be viable.	The following actions will ensure that REWIRE remains a competitive, viable option: • Keep up to date with technological research and aim to utilise new technology (developments in electrolysers, fuel cells and hydrogen storage options) • Establish connections with relevant technology developers	Technological	Enabler

STEEPLE Analysis

ID	Summary	Description	Mitigating/Exploiting Action(s)	STEEPLE Factor(s)	Barrier/Enabler
11	Hydrogen UK Strategy Alignment	REWIRE **aligns well with Government's Hydrogen UK Strategy** [1] which could result in potential subsidies/incentive programmes in the future for customers looking to implement the technology.	Use potential subsidies/incentive programmes as a selling point to accelerate market uptake of REWIRE technology.	Political Social Economic	Enabler
12	DNO to Distribution System Operator (DSO) Transition	The shift towards distributed generation will result in **DNOs to take on the function of DSOs,** such as active network management and improving resilience and security, which REWIRE can support.	Aim to target initial deployment of REWIRE technology in areas most in need of network improvements such as isolated/vulnerable areas.	Technological	Enabler
13	Improved Efficiency	**Utilising the waste heat** from the fuel, as a combined heat and power (CHP) unit, for water/space heating would **improve the efficiency** of the system making it a more competitive choice against other technologies. Integrating with thermal energy storage could significantly reduce energy bills for consumers.	Keep up to date with possible technologies and model and analyse the best possible combination of systems to increase efficiency – this could be developed as part of the Alpha phase.	Technological	Enabler
14	Automotive Developments - Safety	Although hydrogen presents explosion risks, risks associated with batteries also exist – i.e. thermal runaway causing difficulty in extinguishing fires. However, both technologies are **undergoing development in the automotive industry** which poses promise	Keep up to date with developments in safety developments and regulations to ensure least risk possible.	Ethical Social Technological	Enabler

STEEPLE Analysis

ID	Summary	Description	Mitigating/Exploiting Action(s)	STEEPLE Factor(s)	Barrier/Enabler
15	High Speed Deployment	The ability to **rapidly deploy these REWIRE technologies** will provide additional benefits as a flexibility service, through rapid discharge in response to peaks in demand (or reduced supply), as gas peaking power stations are taken offline.	Identify manufacturer/supplier opportunities to ensure availability and high speed deployment. Give manufacturers confidence in future markets, accelerating development and production.	Technological	Enabler
16	Material Requirements	Lithium-ion batteries require more **materials which are in short supply** such as lithium, nickel and cobalt. This leads to shortages and high demand, whereas fuel cells require less short supply materials and also have a longer lifetime.	Keep up to date with technology advancements that may eliminate the requirement of scarce materials altogether. For example, the development of the Membrane-free electrolyser requires no precious metals.	Environmental Ethical	Enabler
17	Storage Regulations	Currently, **COMAH regulations** state that consent is only required when planning to store 2 or more tonnes of hydrogen. The UK Government's Hydrogen Strategy [1], issued in 2021, states that current hydrogen projects can operate under existing regulations, however it also acknowledges that **regulatory changes are likely evolve** as the hydrogen market expand. It is still unknown whether future regulations will present a barrier or enabler.	Keep up to date with upcoming changes to regulations and use any updates to safety legislation as a point of advantage when demonstrating the benefits of REWIRE technology.	Legal Ethical	Enabler

STEEPLE Analysis

ID	Summary	Description	Mitigating/Exploiting Action(s)	STEEPLE Factor(s)	Barrier/Enabler
18	New Markets Integration	REWIRE could **integrate with new emerging markets**, such as hydrogen boilers, which may expand, due to Government actions such as restrictions on gas boilers.	Work with emerging markets/developments to collaborate and generate an integrated system that provides maximum benefit – such as combined heating and electricity.	Legal Technological	Enabler
19	Low Round Trip Efficiency	As a stand alone for electricity supply and storage, REWIRE technology has **low round trip efficiency compared to batteries.**	Research combinations/developments of technology that will make REWIRE a more competitive, viable option when compared to other solutions. Hydrogen storage is also more suitable for long-term storage than batteries.	Technological	Barrier
20	Physical Footprint	This technology has a **moderate physical footprint** and would probably **require outdoor installation.** Therefore, it is easier to install in rural areas where there is more space, despite the fact that populations are concentrated in urban centres – where demand is higher and space is a limiting factor. **Safety in dense spaces is an additional consideration.**	Consideration should be given to benefits of larger-scale solutions that could be implemented at a town/community level rather than individual households. This would also allow occupancies such as flats to benefit where installation would not be possible for an individual dwelling. The results from the network archetype analysis demonstrated that rural areas are more at risk to poor resilience.	Social Technological Economic	Barrier
21	Supply Chain Disruption	Natural disasters and geopolitical conflict can **cause disruption to supply chains**, impacting manufacturing and delivery of parts and products, particularly catalyst materials. This could have a significant impact on an already, niche and not well developed supply chain of equipment.	Aspects of manufacturing could be localised. Contingency plans for supply of products can be put into place in such a scenario.	Technological Political	Barrier

STEEPLE Analysis

ID	Summary	Description	Mitigating/Exploiting Action(s)	STEEPLE Factor(s)	Barrier/Enabler
22	Regulation and Investment Uncertainties	Uncertainty around investment due to undecided policies and regulations. Notably, there has yet to be a formal decision on hydrogen heating.	Advise government on grid and consumer level benefits of REWIRE.	Political	Barrier
23	Mature Battery Market	Battery technology efficiency is currently higher than proposed REWIRE technology and is also a **more mature, consolidated market.** Recent developments have also seen sodium-ion batteries as an emerging technology which could offer cost, safety, sustainability and performance benefits compared to their lithium-ion counterparts.	Raise awareness of other benefits of REWIRE technology that cannot be provided by a lithium-ion battery, such as: • Fuel cells don't degrade in the same way as batteries, meaning a longer lifespan and added environmental benefit. • Fuel cells tend to have faster refuelling times than battery charging. • Aligns with UK Government's Hydrogen Strategy [1], which may result in more hydrogen related technologies and possible incentive schemes.	Technological	Barrier
24	Negative Public Perception	A 2019 survey, conducted by Newcastle University and funded by Ofgem [4], showed that **public knowledge and understanding of hydrogen as fuel in homes is low** and 44% of respondents indicated that they would be **worried about possible gas leaks, fires and explosions.** There is also notable backlash from residents in areas being proposed for the Hydrogen Village Trials [7].	• Use public opinion surveys as a decision making tool during REWIRE development. • Develop a public engagement plan/strategy to engage and inform of the benefits and safe handling of hydrogen. • Demonstrate the safety of REWIRE technology during the Beta phase trial.	Social Technological Ethical	Barrier

STEEPLE Analysis

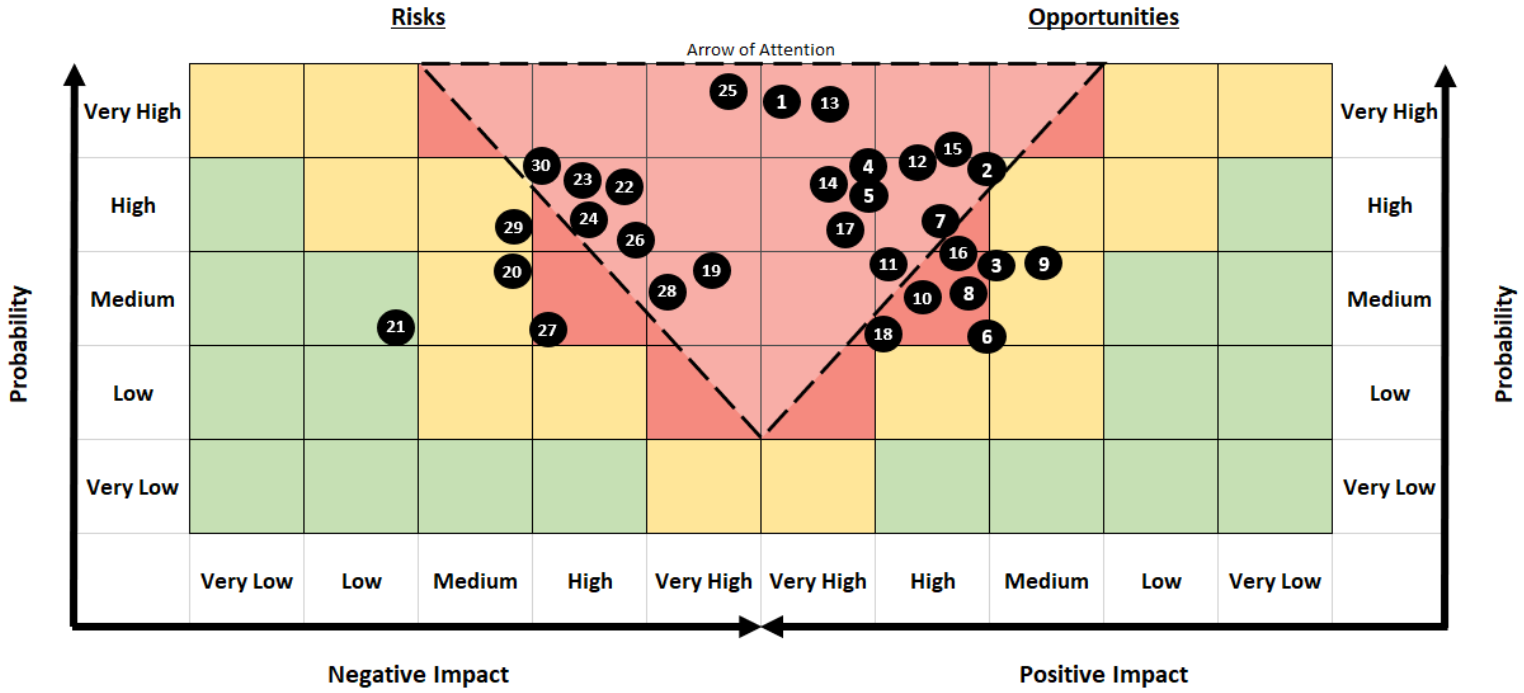
ID	Summary	Description	Mitigating/Exploiting Action(s)	STEEPLE Factor(s)	Barrier/Enabler
25	Consumer Affordability	The higher cost of this technology means that **uptake could be restricted to those who can afford it** – and not necessarily those who need it the most.	Advancements in technology and uptake by the public will bring down the cost. By ensuring REWIRE keeps up to date with these advancements, the cost to consumers can be decreased. Grants and means tested loans could also be explored to enable access for lower income households.	Social Economic	Barrier
26	Ofgem DNO Asset Restrictions	Ofgem has **strict regulations around DNOs ability to own electricity generating and storage assets** [5][6]. This could lead to complications in whether the DNOs could justify supporting with upfront costs, should deployment be mostly for grid resilience benefits.	Work with Ofgem and regulating bodies to understand exceptions and possible exemptions during Alpha phase.	Legal	Barrier
27	Leasehold Developments	Around 20% [2] of properties are **leasehold** in England and 16% [3] in Wales. This could impact uptake of REWIRE technology, in comparison to freehold properties, due to difficulties and constraints in **gaining consent for home improvements.**	Work to raise awareness and issue guidance to public around how to spot when consent is required, and how to ask for consent, etc, so as not to negatively impact uptake of REWIRE technology. Also, follow trends in how other, more mature technologies approach this issue, such as ground source heat pump deployment.	Social Legal	Barrier
28	Impact of Changing Grid Demand	Large uptake of distributed storage, such as REWIRE or battery technology, would result in **significant changes to demand on the grid which could result in different grid operating measures.** For example, it may result in different tariffs if vast amounts of people try to avoid peak prices by use of behind the meter applications.	Energy suppliers must consider how their strategic decisions will impact the national market, consumers and themselves, whilst enabling deployment of these technologies so as not to negatively impact uptake.	Economic Social	Barrier

STEEPLE Analysis

ID	Summary	Description	Mitigating/Exploiting Action(s)	STEEPLE Factor(s)	Barrier/Enabler
29	Lack of Hydrogen Infrastructure	Currently, the capabilities of REWIRE would be limited to only electricity grid interaction as there is **no hydrogen supply/grid connection.**	Keep up to date with hydrogen project developments and the UK Hydrogen Strategy to seek potential opportunities. Can be deployed in the short-term on the gas grid, through reforming the gas prior to feeding the fuel cell.	Technological	Barrier
30	Scalability of Electrolyser	Work conducted during the WP1 technology viability assessment indicates that manufacturers have scaled PEM electrolyser sizes to **several orders of magnitude greater than those suitable for domestic application.**	Demonstrate there is a market at this scale with the commercialisation of related technology. Wait for new, equivalent technologies to mature at this scale, such as reversible fuel cells.	Technological	Barrier

Barriers and Enablers Map

Each barrier and enabler has been plotted against the probability of occurring and the level of impact it would have.
Barriers and enablers which overlap with the arrow of attention are considered of particular importance and should be considered most when trying to mitigate risks and exploit opportunities.



ID	Summary	ID	Summary
1	Maximising renewable energy	15	High speed deployment
2	Investment cost decreasing	16	Material requirements
3	Decentralised grid transition	17	Storage regulations
4	Consumer bill reduction	18	New markets integration
5	DNO fine reduction and costs	19	Low round trip efficiency
6	Gas/electricity optionality	20	Physical footprint
7	Supporting isolated/vulnerable consumers	21	Supply chain disruption
8	Grid Balancing Mechanisms	22	Regulation and investment uncertainties
9	Positive public perception	23	Mature battery market
10	Overseas large-scale deployments	24	Negative public perception
11	Hydrogen UK Strategy alignment	25	Consumer affordability
12	DNO to DSO transition	26	Ofgem DNO asset restrictions
13	Improved efficiency	27	Leasehold developments
14	Automotive developments – safety	28	Impact of changing grid demand
		29	Lack of Hydrogen Infrastructure
		30	Scalability of Electrolyser

Red text highlight factors that fall within the arrow of attention.

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[1] HM Government. *UK Hydrogen Strategy.* London : Crown Copyright, 2021.
[2] Department for Levelling Up, Housing & Communities. Official Statistics Leasehold dwellings, 2020 to 2021. *Gov.uk.* [Online] July 7, 2022. [Cited: May 16, 2023.] https://www.gov.uk/government/statistics/leasehold-dwellings-2020-to-2021/leasehold-dwellings-2020-to-2021#:~:text=In%202020%2D21%2C%20there%20were,of%20the%20English%20housing%20stock.
[3] Carr, H, et al. *Research into the sale and use of leaseholds in Wales: summary.* Cardiff : Welsh Government, 2021.
[4] Scott, M and Powells, G. *Blended Hydrogen: The UK Public's Perspective.* Newcastle upon Tyne : Newcastle University, 2019.
[5] Ofgem. Prohibition on Generation Guidance (POGG). *Guidance.* [Online] February 23, 2021. [Cited: May 16, 2023.] https://www.ofgem.gov.uk/sites/default/files/docs/2021/02/storage_ownership_publications_guidance_v4_0_0.pdf.
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Roadmap

Highlights the technological and external factors impacting REWIRE's route to commercialisation



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Possible REWIRE Solutions

The preliminary results of WP1 and WP2 indicate that:

- The presence of a hydrogen network makes the solution significantly more feasible, due to limitations on domestic storage and electrolyser technology not being available at this scale.
- The fuel cell, utilised as a CHP unit and coupled with thermal energy storage (latent heat for intraday) and a top-up boiler, can be used to generate domestic power and heat, whilst additionally offering opportunity to export electricity during periods of high demand. This can result in consumer bills that allow for a payback period comparable with a heat pump and Tesla Powerwall (fully electrified system).
- The solution has the potential to offer electricity and hydrogen network resilience via fuel cell and storage, respectively.

The road mapping exercise considers high-level technical and external influences that may impact the following possible REWIRE solutions:

Solution 1

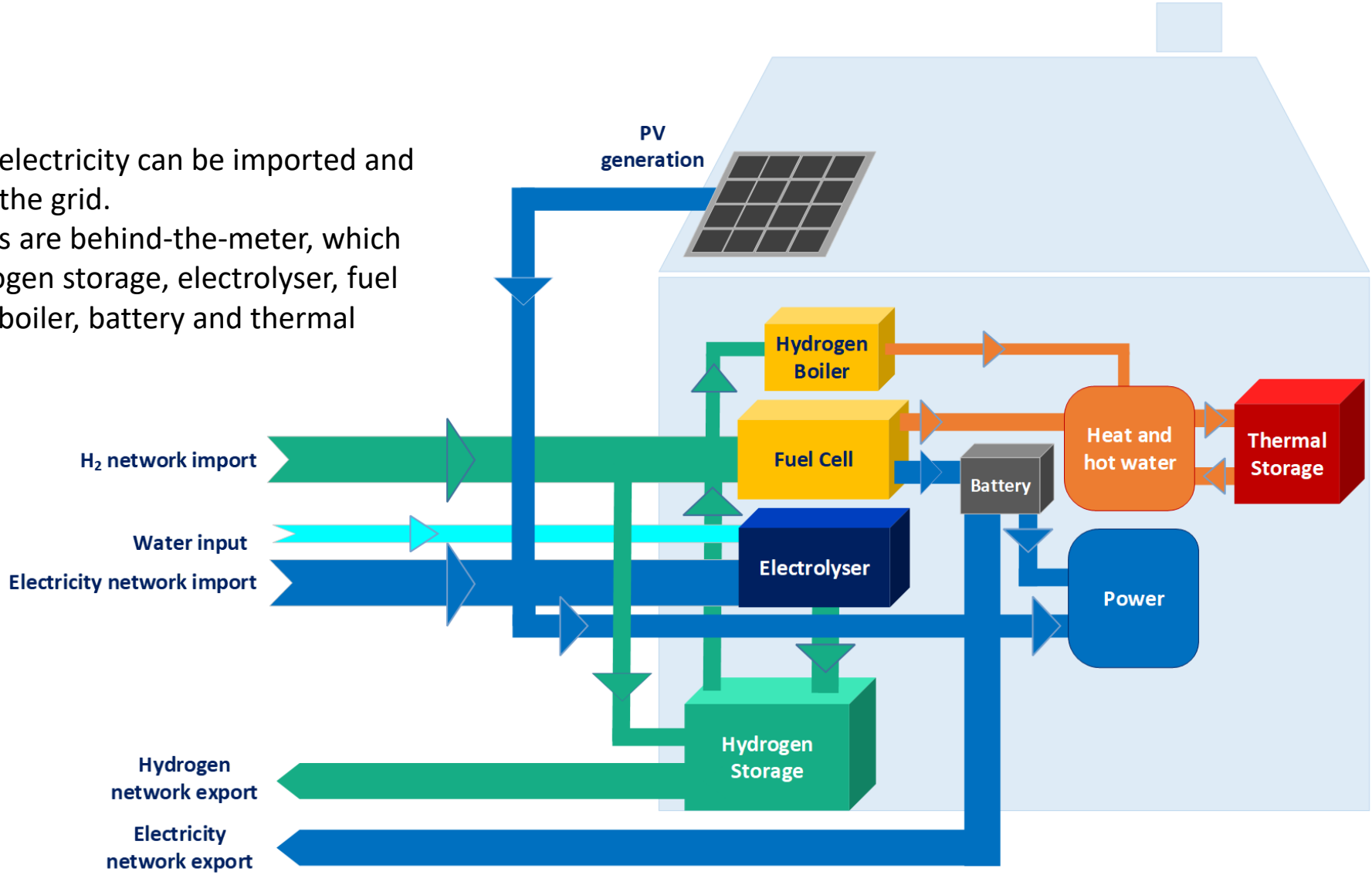
- All components behind-the-meter.

Solution 2

- Behind-the-meter electrolyser removed.

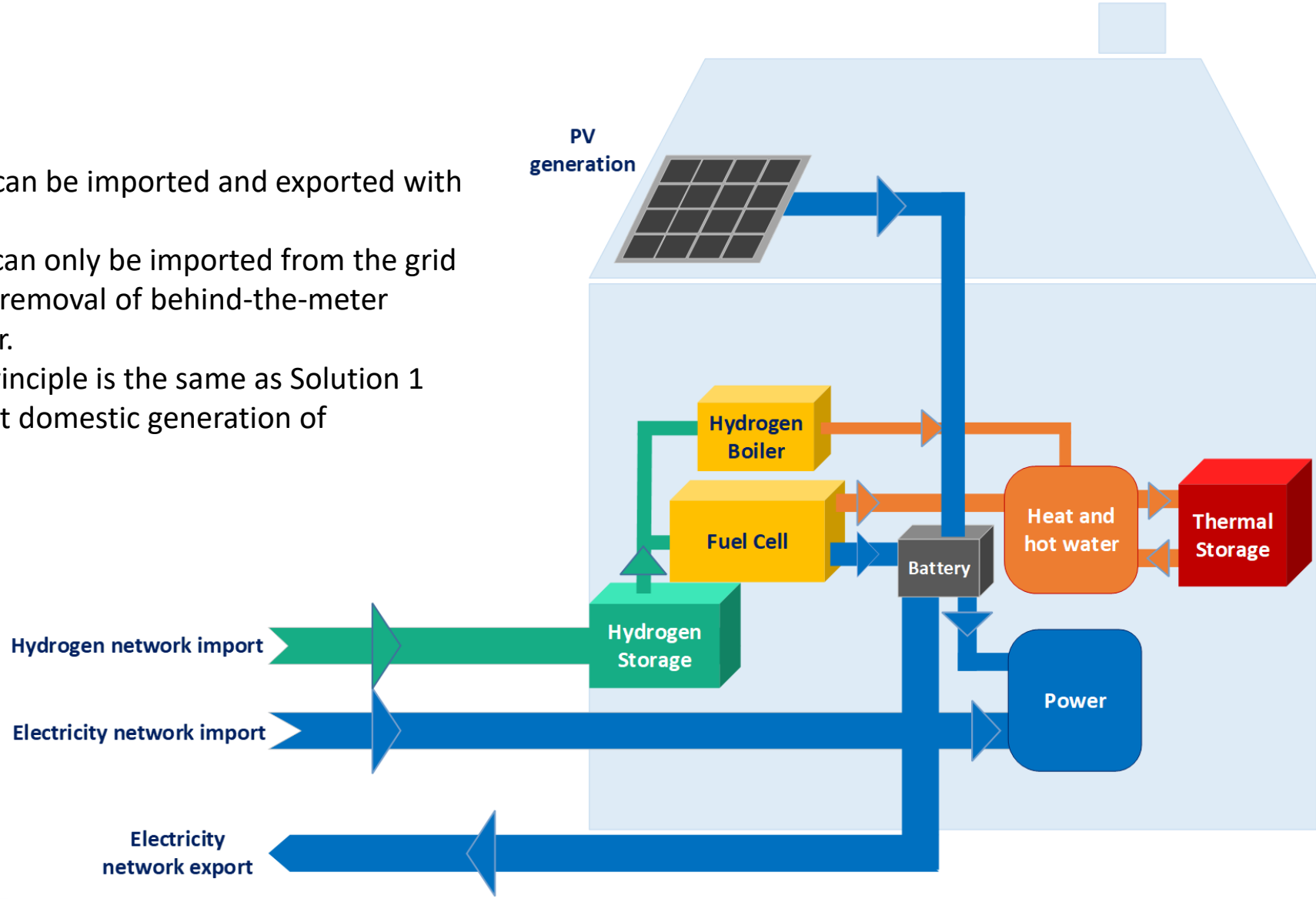
Solution 1

- Hydrogen and electricity can be imported and exported with the grid.
- All components are behind-the-meter, which includes: hydrogen storage, electrolyser, fuel cell, hydrogen boiler, battery and thermal storage.

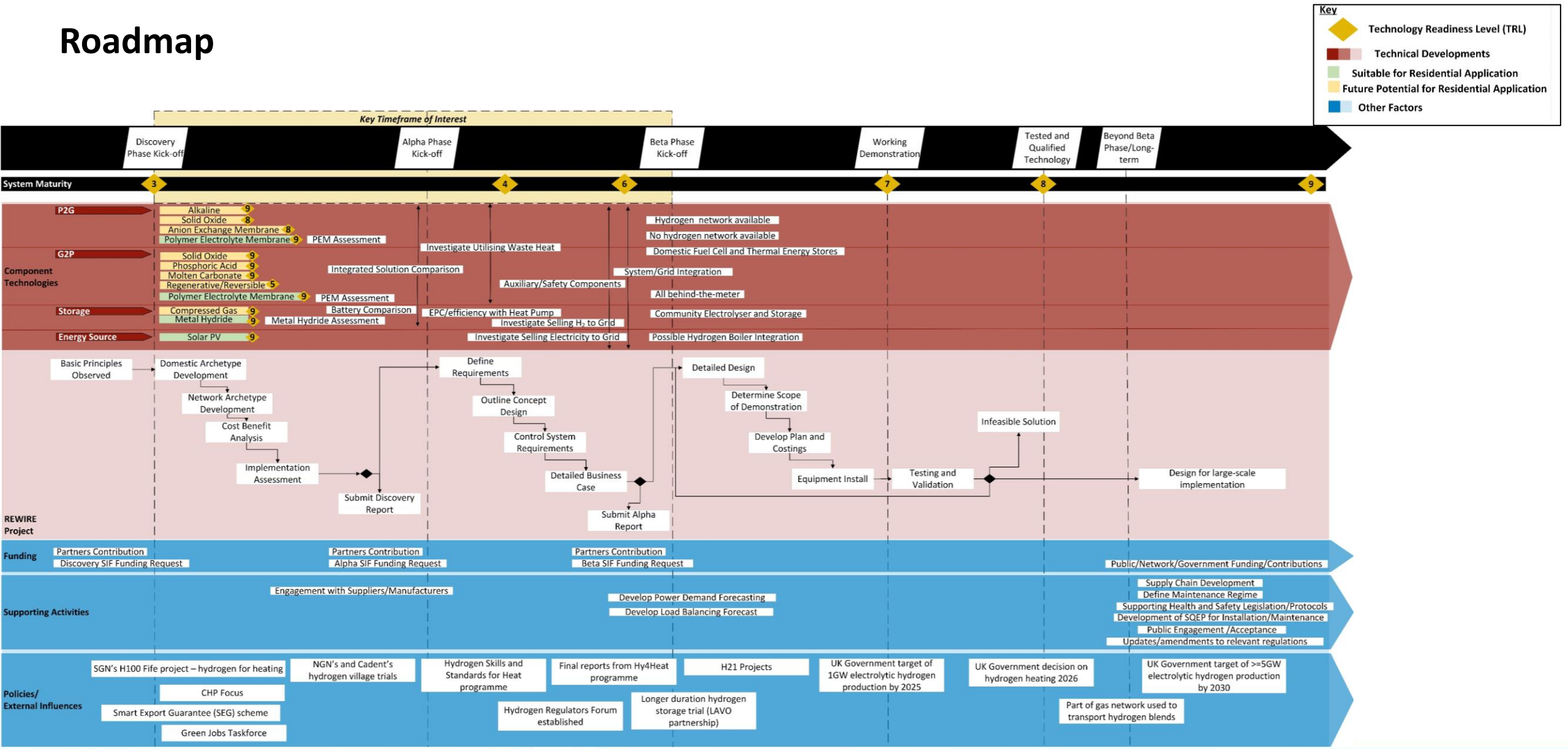


Solution 2

- Electricity can be imported and exported with the grid.
- Hydrogen can only be imported from the grid due to the removal of behind-the-meter electrolyser.
- Working principle is the same as Solution 1 but without domestic generation of hydrogen.



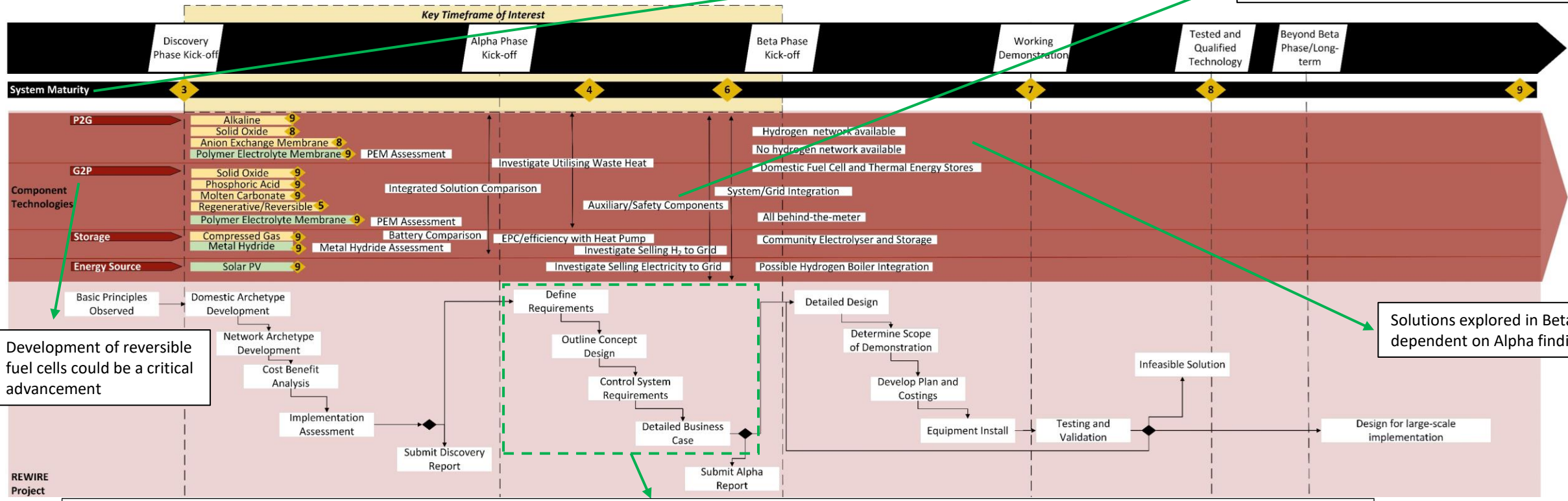
Roadmap



Roadmap – Technical Developments

System maturity refers to integrated maturity of the whole system

May include components such as: pumps, compressors, rectifier, water purifier but is heavily dependent on the solution chosen for Alpha/Beta



Development of reversible fuel cells could be a critical advancement

Solutions explored in Beta dependent on Alpha findings.

Potential Sub-activities to consider:

Define Requirements
- Define (max 2) scenarios for detailed analysis
- Stakeholder requirements
- System requirements

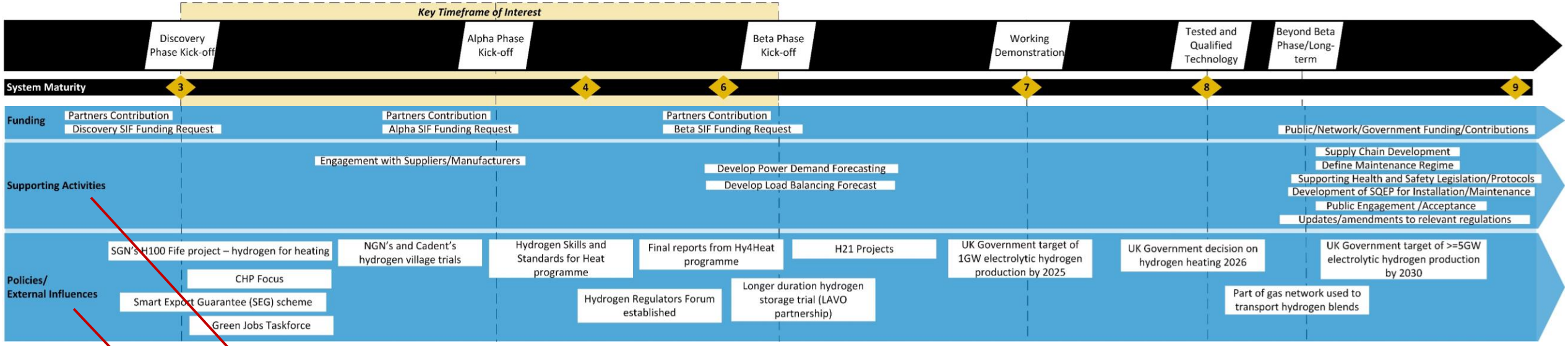
Outline Concept Design
- Siting analysis
- Identifying and sizing components
- Develop concept P&ID and PFD
- Safety Assessment – HazID
- Identify lead-times

Control System Requirements
- Policy and Regulatory Assessment
- Market/Consumer Fairness Analysis
- Tariff optimisation and considerations
- Preliminary domestic controller logic development
- Preliminary grid controller logic development
- Identify lead-times

Detailed Business Case
- Supply chain assessment
- Whole system resilience benefits
- Lifecycle analysis – carbon benefit assessment
- Domestic CBA
- Network CBA

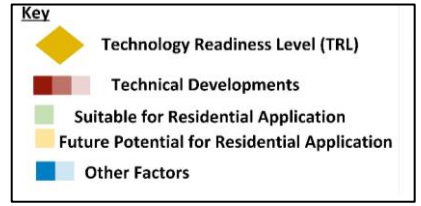
Key
- Technology Readiness Level (TRL)
- Technical Developments
- Suitable for Residential Application
- Future Potential for Residential Application
- Other Factors

Roadmap – Other Factors



These are activities that will heavily influence the success and wide-scale adoption of REWIRE implementation but can only be influenced by REWIRE and not fully controlled.

These activities highlight government aims, project developments and government decisions on future policies which may heavily impact the future feasibility of REWIRE. Particular focus has been given to the hydrogen space as current major barriers are hydrogen cost and supply chains which may become more abundant if the UK sees an in increasing shift towards hydrogen technologies and usage.



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[1] Department for Business, Energy & Industrial Strategy. *Hydrogen Strategy update to the market: July 2022.* London : Crown Copyright, 2022.
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Risks

Risk register highlighting potential, high-level project risks for REWIRE development



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Project Risks

Risk ID	Risk Title	Project Phase	Risk Description	Risk Likelihood	Risk Severity	Risk Score	Mitigation	Likelihood Post-Mitigation	Severity Post-Mitigation	Score Post-Mitigation
1	Public Perception	Beta/BAU	Disruption and cost to customers caused by system implementation during potential business as usual activities which could result in negative public perception.	4	4	16	Roadmap to business as usual has been planned to enable identification of additional requirements and to consider public engagement.	3	4	12
2	System Integration	Alpha/Beta	There is a risk that tests and systems may fail, caused by incompatibility of whole systems technical integration resulting in incomplete delivery of the testing programme/demonstration.	3	5	15	Implement a structured design review process utilising skills and expertise from all project partners to enable corrective actions before design finalisation and equipment procurement.	2	5	10
3	Unstable Energy Costs	Beta/BAU	Project financial projections may change caused by fluctuations and unpredictable energy costs over the long-duration of the Beta phase. This may result in a decreased cost-benefit viability of the project.	3	4	12	Utilising a stage-gate approach to ensure cost associated risks are identified and managed with an appropriate level of contingency reserve which can be reviewed and managed.	3	3	9
4	Skills Gap	Beta/BAU	Improperly installed equipment caused by lack of training could affect test results and future rollout.	3	4	12	The Beta phase site location should be chosen so there is access to skilled staff, required to run the trial. Also, project partners should have the skills and knowledge to allow communication and training of expertise.	2	4	8

Project Risks

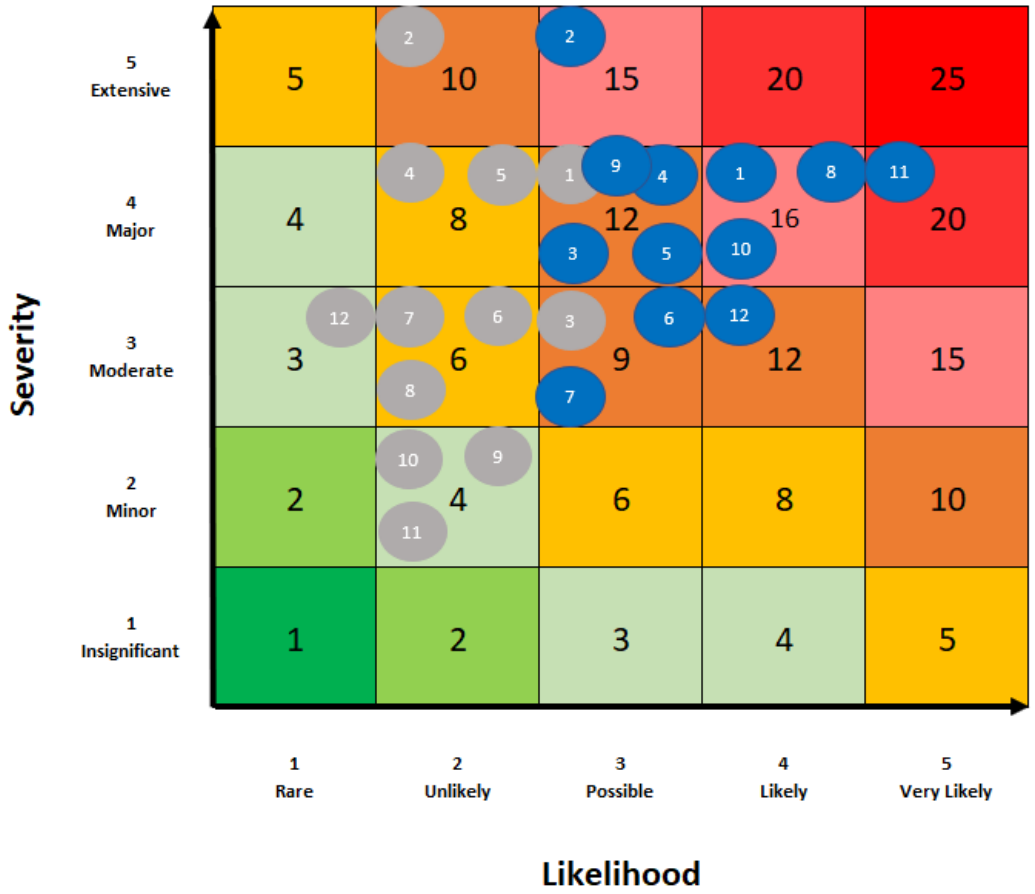
Risk ID	Risk Title	Project Phase	Risk Description	Risk Likelihood	Risk Severity	Risk Score	Mitigation	Likelihood Post-Mitigation	Severity Post-Mitigation	Score Post-Mitigation
5	Component Costs	Beta	High costs caused by the system components required may result in decreased cost-benefit viability of the project.	3	4	12	Research component costs to identify main areas which are contributing to expense to enable understanding of drivers for reduction. Also utilise a stage-gate approach to ensure cost associated risks are identified and managed.	2	4	8
6	Supply Chain	Beta	Procurement lead times could be delayed cause by unforeseen supply chain disruptions which could result in late delivery of the project.	3	3	9	Ensure prompt order placement with risk window built in to minimise project impact if delays occur.	2	3	6
7	Severe Weather	Beta	Demonstration sites may be impractical to work on caused by unforeseen circumstances, such as severe weather, which would impact project delivery schedule. Unusual weather patterns could also give misrepresentative results for power generation and domestic demand.	3	3	9	Project schedule should allow for a window of flexibility to avoid such weather if it is forecasted. Alpha phase should provide detailed analysis of historical power generation values to allow accurate assessments in Beta.	2	3	6
8	Hydrogen Price	Beta/BAU	High cost of hydrogen compared to natural gas may make power-to-gas and gas-to-power conversions not beneficial.	4	4	16	Keep up to date with UK's hydrogen stance, and emerging hydrogen market, which will provide insight on the cost of hydrogen over time to ensure most beneficial design is assessed in Beta phase.	2	3	6

Project Risks

Risk ID	Risk Title	Project Phase	Risk Description	Risk Likelihood	Risk Severity	Risk Score	Mitigation	Likelihood Post-Mitigation	Severity Post-Mitigation	Score Post-Mitigation
9	Changing Policies and Regulations	Beta/BAU	BAU operations could be impacted by changing/adapting policies and regulations, particularly around domestic hydrogen use, which could impact wide-scale adoption.	3	4	12	Completion of a policy and regulatory assessment and mapping exercise would identify existing standards and guidance and highlight unknowns/gaps. As part of Alpha and Beta, engagement with experts and regulatory bodies should be planned to progress and minimise potential barriers.	2	2	4
10	Tariff Considerations	Beta/Alpha	Domestic conversion between different vectors could make the market unfair, in favour of consumers with these technologies, allowing them to act as small power generators.	4	4	16	Alpha phase should look to engage with regulating bodies and companies to consider and optimise different tariff solutions to avoid market issues.	2	2	4
11	Component Sizes	Alpha/Beta	There is a risk that supplier options may be restricted due to niche market and limited options of components for domestic application.	5	4	20	Alpha phase should look to establish early engagement with potential suppliers/developers. Discovery Phase outputs already indicate that domestic scale electrolysers are not available, which has allowed for the concept to be updated.	2	2	4
12	Suitably Qualified and Experienced Personnel (SQEP) Unavailability	Alpha/Beta	Unavailability of key resource caused by unplanned leave or conflicting project commitments that could result in schedule delay.	4	3	12	Resource allocation and project plan will be determined at the start of the project with resource pools identified to backfill roles if and when required.	1	3	3

Project Risk Matrix

The risk matrix plots each risk before and after mitigation. Risks in the top right-hand corner are most severe whilst the bottom-left hand corner shows least severe risks.



Key

Pre-mitigation

Post-mitigation

ID	Summary
1	Component Costs
2	Supply Chain
3	System Integration
4	SQEP Unavailability
5	Severe Weather
6	Public Perception
7	Skills Gap
8	Unstable Energy Costs
9	Changing Policies and Regulations
10	Hydrogen Price
11	Tariff Considerations
12	Component Sizes

Conclusions



Conclusions

Based on work completed during Work Package 4 the following can be concluded:

- A series of barriers and enablers have been identified, with associated mitigation or exploitation activities, and these have been used to develop a roadmap for potential commercialisation of the REWIRE design.
- The REWIRE solutions explored could provide potential benefits to the network and consumer but the optimal solution is likely to be heavily dependent on external factors i.e. if hydrogen for heating is rolled out in the UK.
- The main consumer opportunities are flexibility service offerings and bill reduction, whilst the network similarly benefits from reduced outages, grid balancing and increased resilience supporting the shift towards a decentralised grid.
- However, with the UK's current hydrogen landscape, some barriers such as niche supply chains, lack of appropriately sized technologies and lack of UK hydrogen infrastructure may pose some development challenges.