Welsh energy targets review

Graphing outputs

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About Regen

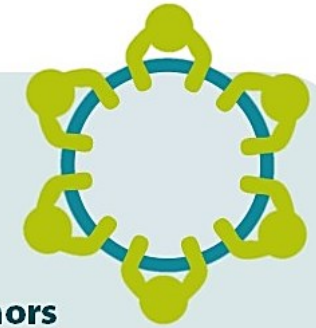
An independent centre of energy expertise, with a mission to transform the energy system for a zero carbon future.

Experts

We approach the energy transition from a position of knowledge and evidence. By understanding the technical, financial, political and societal enablers needed to make sustainable energy work, we can tackle the barriers preventing progress.

Pioneers

We choose to work in areas that are innovative or new. We take on challenges; we get cutting edge projects off the ground and we share the learning to inspire and enable others to follow.



Convenors

We bring the right people and organisations together to create ideas and solutions to achieve change. We work across the energy industry and its wide range of stakeholders.

Introduction

- Regen was commissioned by the Welsh Government to build an evidence base of future Welsh energy trends, with a particular focus on future electricity demand and generation trends.
- This work identifies key Welsh energy trends and provides a graphical summary alongside summary commentary, for inclusion in the Welsh Government's consultation on future energy targets.
- No new primary energy pathway modelling was undertaken for this project, rather existing pathway modelling from the Climate Change Committee and electricity networks were used.
- The primary data sources used for this analysis are from the Welsh Government, Climate Change Committee, National Grid ESO, National Grid Electricity Distribution, SP Energy Networks, and Department for Business, Energy & Industrial Strategy. These data sources have been brought together using Regen analysis and insights.
- Electricity demand figures from the CCC includes demand from agriculture, aviation, fuel supply, manufacturing and construction, non-residential buildings, residential buildings, shipping, surface transport and waste.

Executive summary

Executive summary (1)

The Welsh Government has set a target for Wales to meet the equivalent of 70% of its annual electricity demand from renewable sources by 2030. Welsh Government plans to consult on revising this target; this slide deck summarises some of the evidence, trends and projections for Wales to inform the development of new targets. While there are uncertainties about Wales' specific decarbonisation pathway, its abundant energy resources are more than sufficient to enable Wales to meet the challenge.

Changing energy trends

All net zero energy pathways identified for Wales foresee dramatic changes in Wales' energy demand trends. Although the route to decarbonisation in some sectors remains somewhat uncertain, the decarbonisation of electricity in the near and medium term is central to all net zero pathways. Furthermore, electricity demand is expected to increase at least two-fold in all net zero pathways. These factors make the sustained deployment of renewable electricity generation projects critical for achieving net zero.

An abundance of renewable electricity resources

Wales' abundant renewable energy resources, documented in various sources ([1,2,3,4]), make it well equipped to take a leading role in achieving a decarbonised energy system. This analysis identified that these resource opportunities are more than sufficient to match or exceed future projections of electricity demand.

Over 4.2 GW pipeline of electricity generation projects identified

An analysis of active and in-development renewable electricity generation projects has identified a potential pipeline of 4.2 GW of onshore and offshore projects. Approximately 1.7 GW of this pipeline is made up of onshore wind and solar PV, most of which has an accepted grid connection. Approaching 2.5 GW of in-development offshore wind projects were identified. While this healthy pipeline of projects, if deployed, could approximately double current Welsh renewable electricity generation, it is not substantial enough to match future Welsh electricity demand. Less than 1 GW of the in-development projects are deemed to be at an advanced stage of planning or development.

Sources: [1] Welsh Government, Assessment of on-shore wind and solar energy potential in Wales, 2019. [2] National Grid ESO, FES 2022. [3] WPD DFES, 2021. [4] SPEN DFES, 2021.

Executive summary (2)

regen transforming energy

Achieving the current 2030 target is uncertain and is likely to be dependent on offshore wind deployment

Analysis of the pipeline of in-development projects indicates that achieving Wales' existing 2030 electricity generation target is currently highly reliant on the successful development of existing in-development offshore wind projects. Given that these offshore projects tend to involve protracted development timescales, achieving the 2030 target is dependent on the successful development of projects already in the pipeline.

Delivering a higher 2035 target would require significant new onshore and offshore projects to begin development in the next 5 years

Given the historically long development timescales for large-scale renewables, there is a narrow window of time for new large-scale onshore and offshore wind projects to begin development in the coming years to contribute to a potential 2035 target.

Onshore renewable energy development remains vital but has significant challenges to overcome

This analysis demonstrates that in all net zero pathways renewable energy deployment must accelerate and be sustained for the next three decades – at a rate greater than that achieved over the last decade. There are significant barriers to deployment, as identified through the Renewable Energy Deep Dive, such as securing a financially viable grid connection, gaining planning permission and lack of financial support. Consequently, actions to support the development of renewables in Wales are vital, such as the Bill on Infrastructure Consenting, the creation of a national energy plan and target development. The recent announcement of the creation of a state-owned energy developer should help to scale up renewable energy rollout in Wales.

Both large-scale (>1 MW) and small-scale (<1 MW) renewable technologies have a role to play, but the dominant technologies for renewable electricity generation are projected to be large-scale offshore, onshore wind and solar PV

While every kWh of renewable electricity generation is of relative equal decarbonisation value, an estimated 90% of projected renewable electricity generation in Wales will be delivered by large-scale renewable electricity projects, primarily from offshore and onshore wind farms and solar farms.

Welsh renewable electricity generation trends

Welsh electricity generation trends

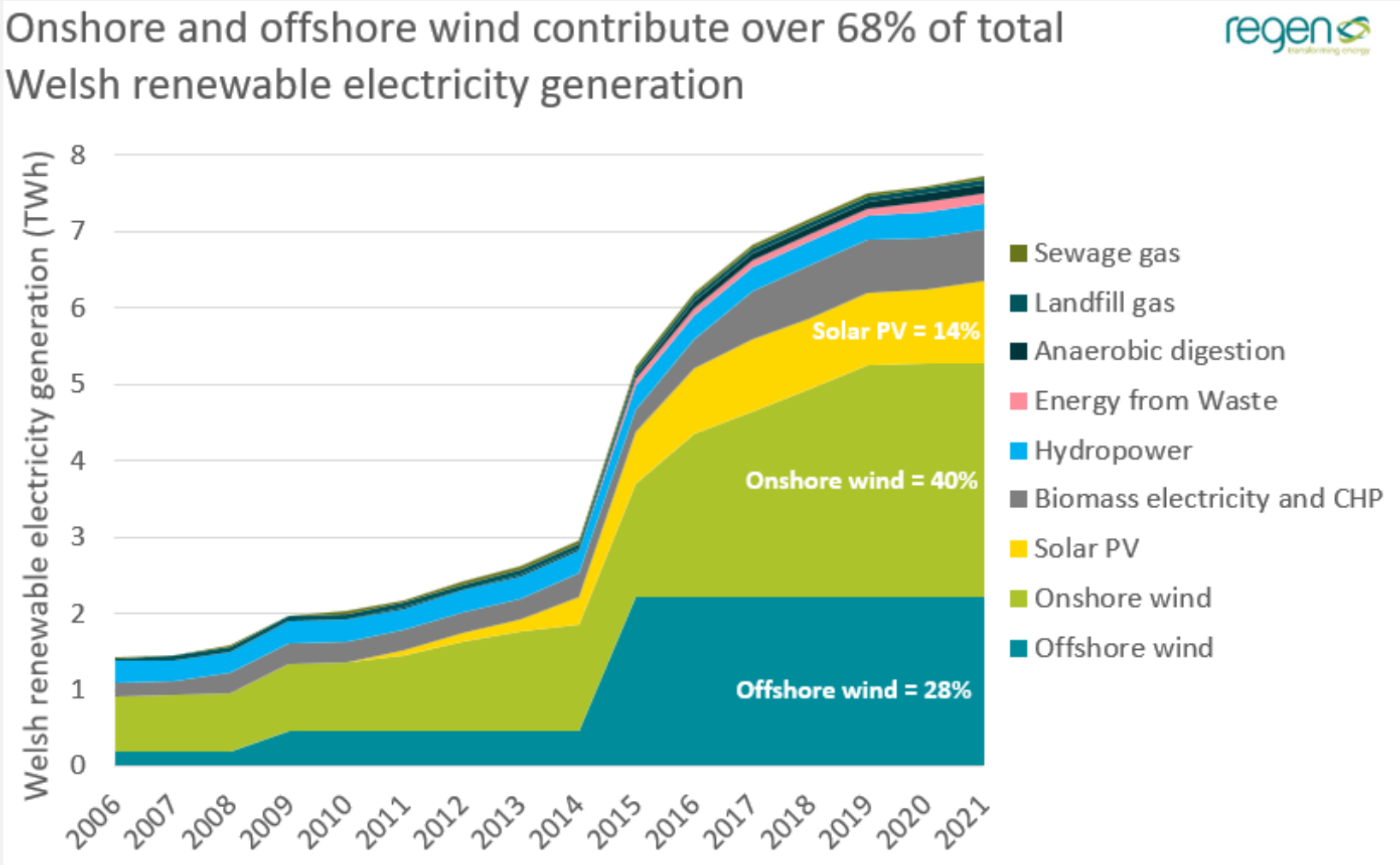


Figure 1: Welsh renewable electricity generation trends by technology over time.
Source: Welsh Government, Energy Generation in Wales 2021; Regen analysis.

- Onshore and offshore wind accounted for over two thirds of Welsh renewable electricity generation in 2021, a trend that has remained approximately the same since 2006.
- Renewable electricity generators in Wales are estimated to generate 7.7 TWh annually.
- Between 2014 and 2017, renewable electricity generation in Wales more than doubled, from around 3 TWh to nearly 7 TWh. Since then, the annual increase in renewable electricity generation has slowed.

Welsh renewable electricity trends

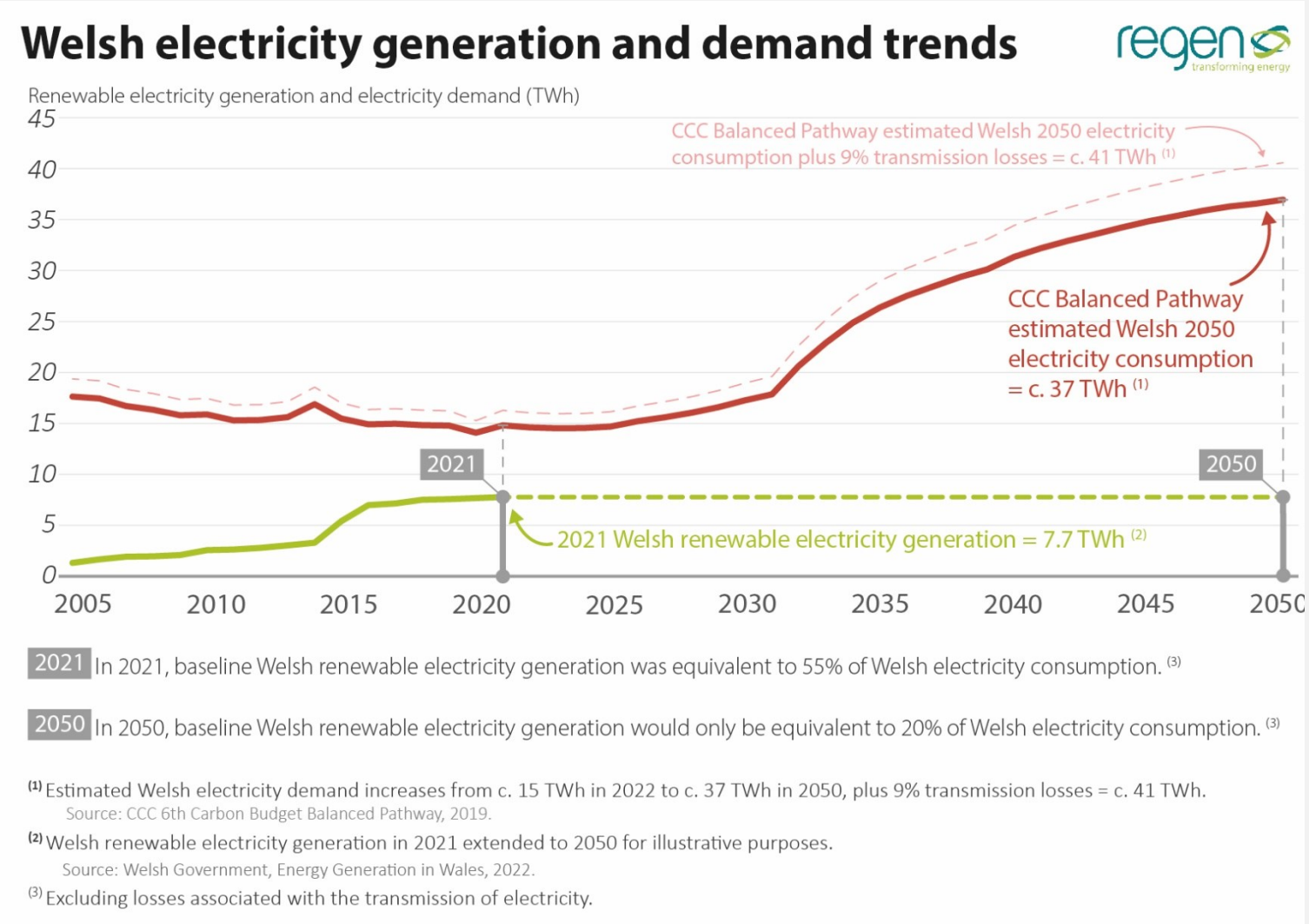


Figure 2: Historic and future projection of Welsh electricity demand, plotted alongside Welsh renewable electricity generation baseline.
Source: Welsh Government, Energy Generation in Wales 2021; CCC 6th Carbon Budget; Regen analysis.

- In 2021, Welsh renewable electricity generation met the equivalent of 55% of Welsh electricity consumption.
- Electricity consumption in Wales is projected to increase significantly, meaning that by 2050 baseline renewable electricity generation would be equivalent to just 20% of Wales' projected 2050 electricity consumption (in the CCC's balanced pathway).

Future Welsh energy demand trends and sensitivities

CCC Welsh energy demand trends by fuel

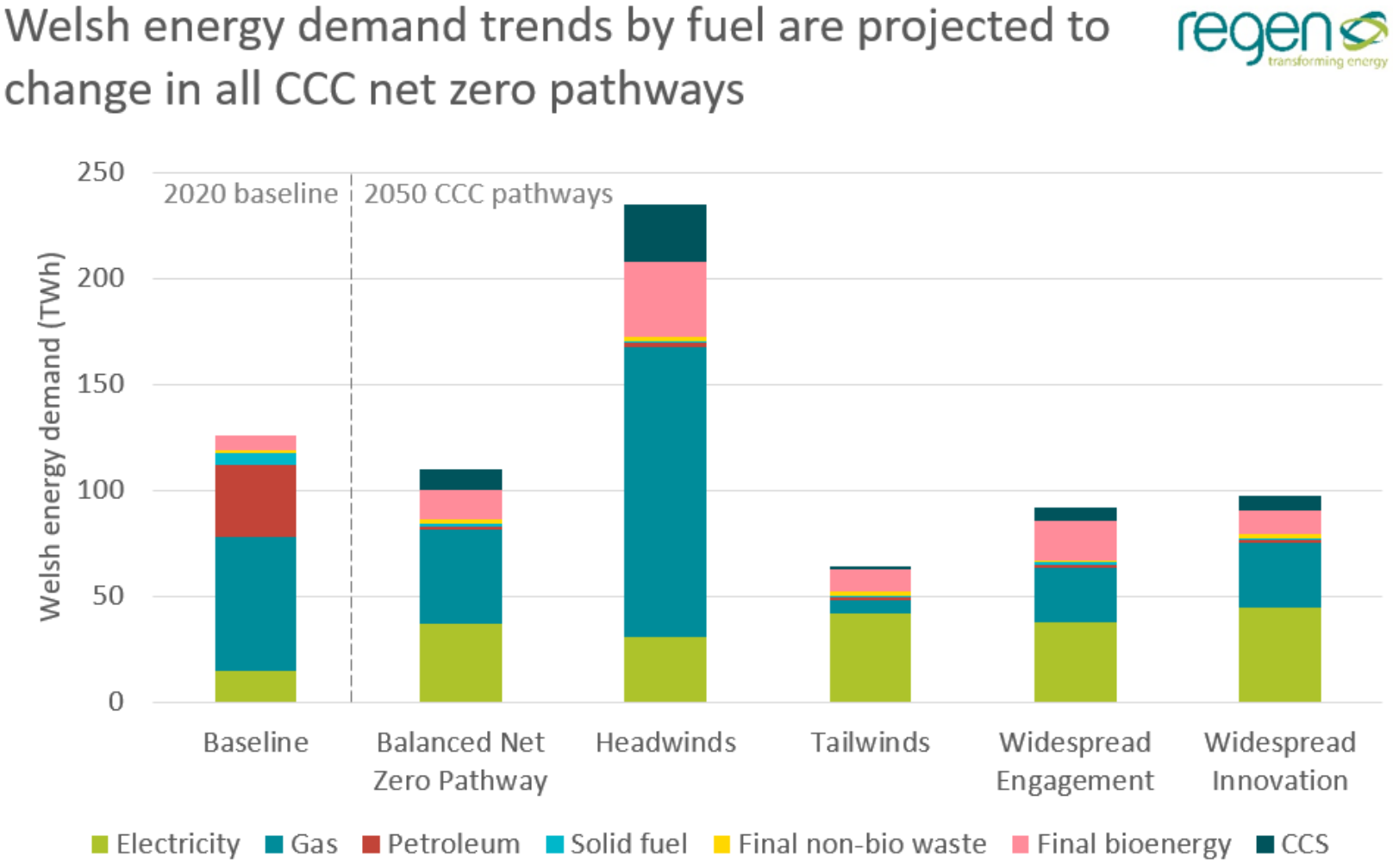


Figure 3: Baseline and future pathways of Welsh energy demand by fuel.
N.b. Hydrogen consumption has been excluded to avoid duplication, with primary energy consumption for hydrogen production predominantly accounted for through gas and electricity demand.
Source: CCC 6th Carbon Budget; Regen analysis.

- BEIS reported 2021 Welsh energy consumption as 94 TWh, excluding exported energy.
- CCC reported 2021 Welsh energy demand as 126 TWh, including exported energy.
- CCC net zero pathways for energy consumption in Wales project dramatic shifts in energy demand trends by fuel.
- All pathways see an increase in electricity demand of between approximately 100% and 200%.
- Fossil gas demand pathways are highly variable, from a 100% increase to a 91% decrease.

CCC Welsh electricity demand trends (1)

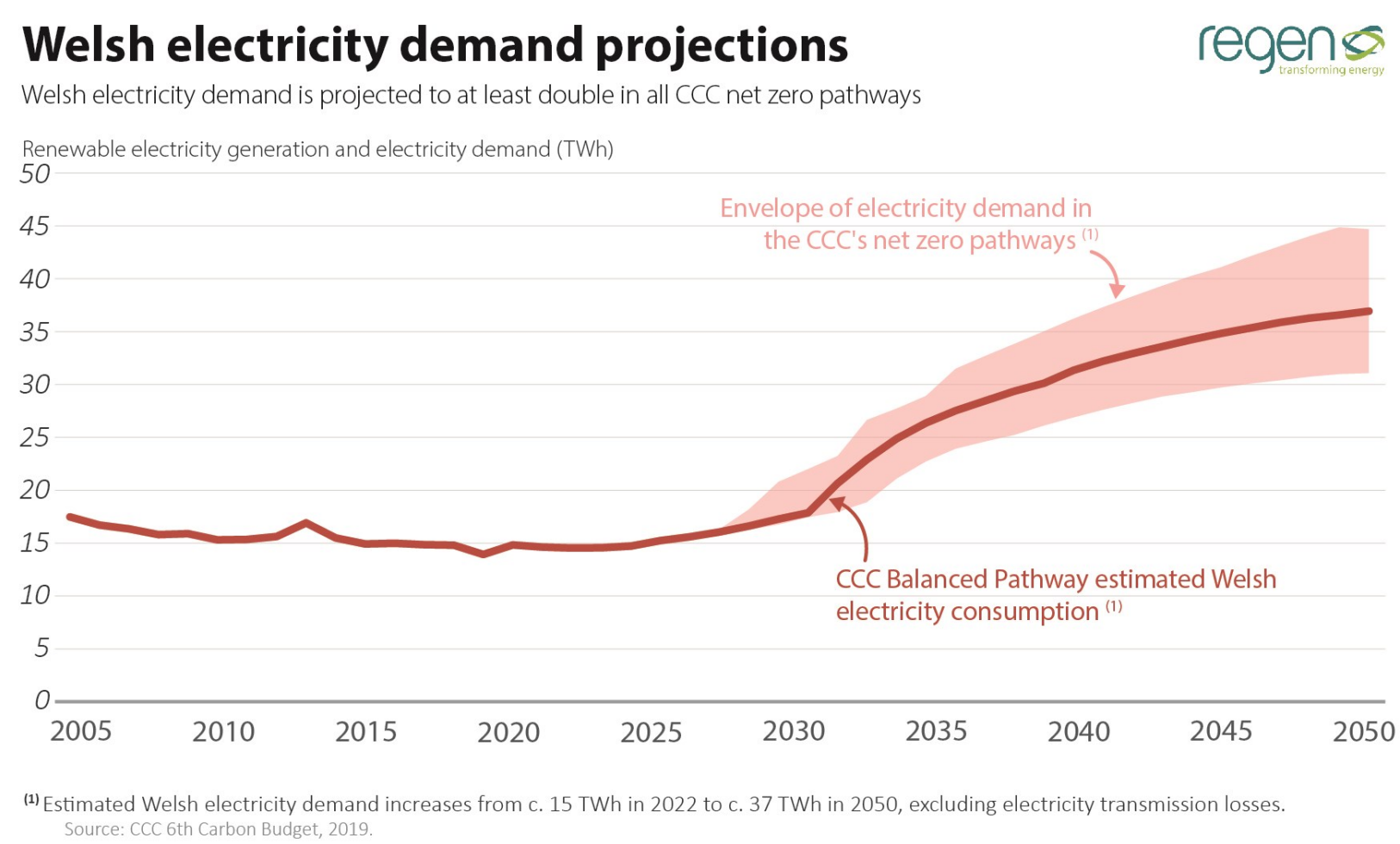


Figure 4: Historic and future scenario-based projections of Welsh electricity demand. The CCC Balanced pathway is plotted within the envelope of the CCC's other net zero pathways.
Source: CCC 6th Carbon Budget; BEIS sub-national electricity consumption, 2020; Regen analysis.

- Welsh electricity demand is projected to at least double in all CCC net zero pathways.
- Electricity demand varies in each pathway due to a wide variety of factors, including:
  a. The extent to which hydrogen is produced via electrolysis using electricity or produced via gas reformation/gasification using fossil gas.
  b. The extent to which heating in buildings is electrified or converted to hydrogen.
  c. The extent to which Carbon Capture and Storage (CCS) is realised in the power, manufacturing and industrial sectors.
  d. The deployment of energy efficiency measures.
- Shifting the relationship between these factors could see future electricity demand in Wales varying by greater amounts than that illustrated in this graph.

CCC Welsh electricity demand trends (2)

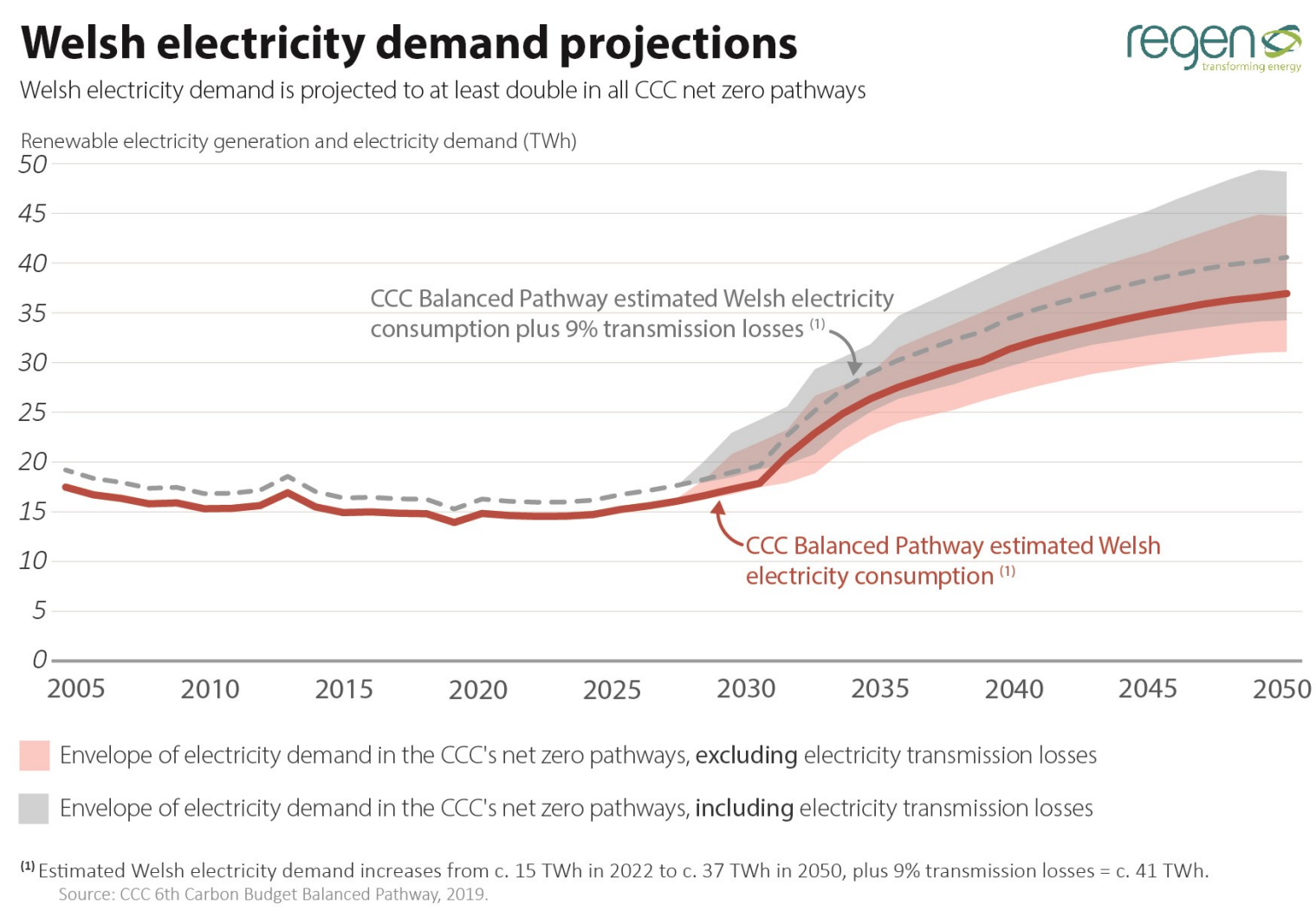


Figure 5: Historic and future scenario-based projections of Welsh electricity demand. The CCC Balanced pathway is plotted within the envelope of the CCC's other net zero pathways.
Source: CCC 6th Carbon Budget; Regen analysis.

- Electricity transmission losses could be considered for inclusion within calculations for future 100% Welsh renewable electricity generation targets.
- Electricity transmission losses predominantly arise from some energy being dissipated as heat due to electrical resistance in the network. The CCC assume transmission losses are approximately 9%.
- It is estimated, therefore, that electricity transmission losses could effectively increase Welsh electricity demand from approximately 37 TWh to 41 TWh, in the CCC's Balanced Pathway.

CCC Welsh electricity demand sensitivities

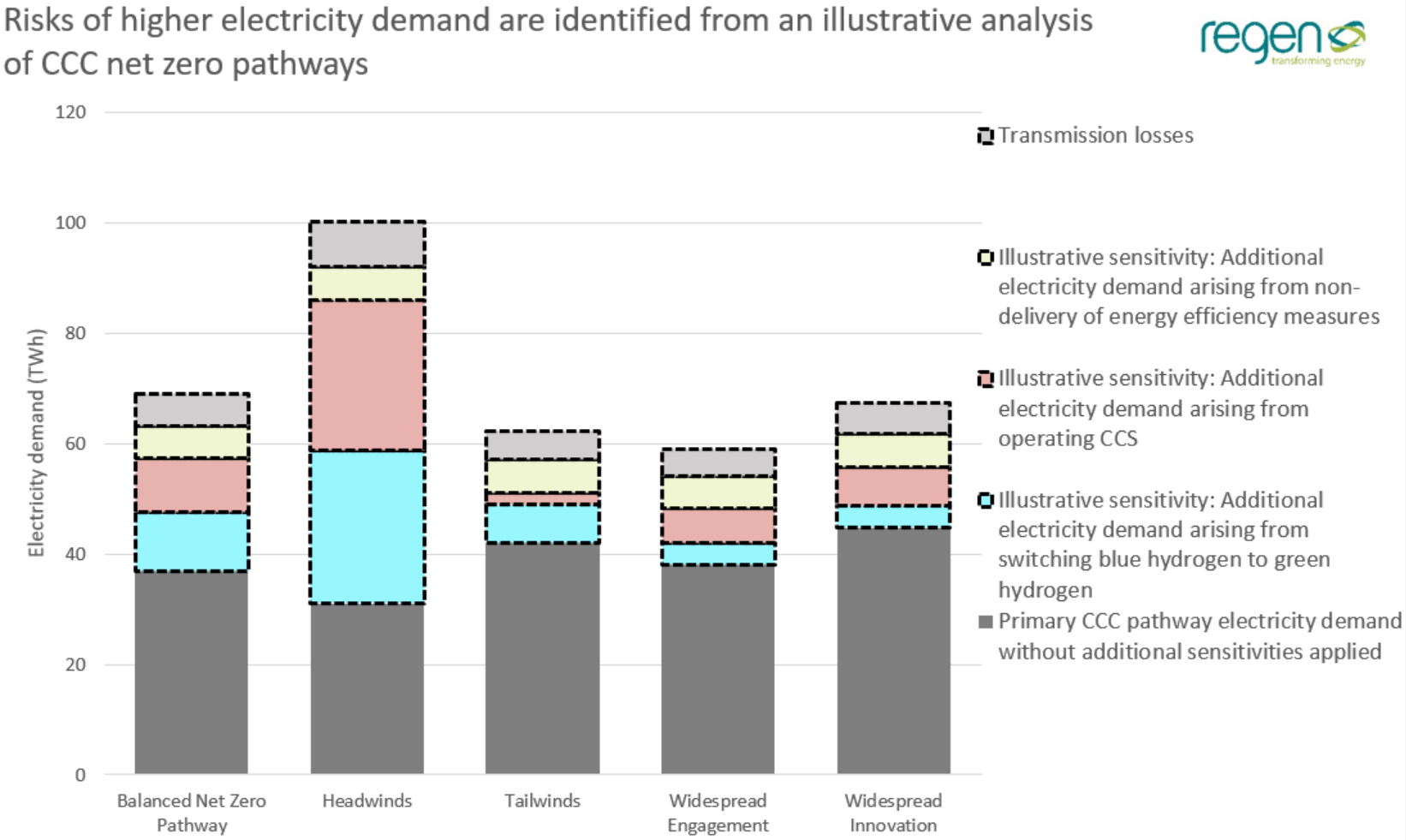


Figure 6: Electricity demand sensitivities for illustrative purposes.
Source: Primary electricity demand published by CCC 6th Carbon Budget; Sensitivities analysed by Regen.

- For illustrative purposes, this graph demonstrates at a high-level the impact that varying specific assumptions could have on electricity demand.
- It should be noted that the CCC pathways were designed to capture the uncertainty across different mitigation pathways in all the sectors. However, specific policy decisions or not achieving goals and assumptions within the pathways could have an impact on electricity demand and even the deliverability of certain pathways.

CCC Welsh energy demand trends

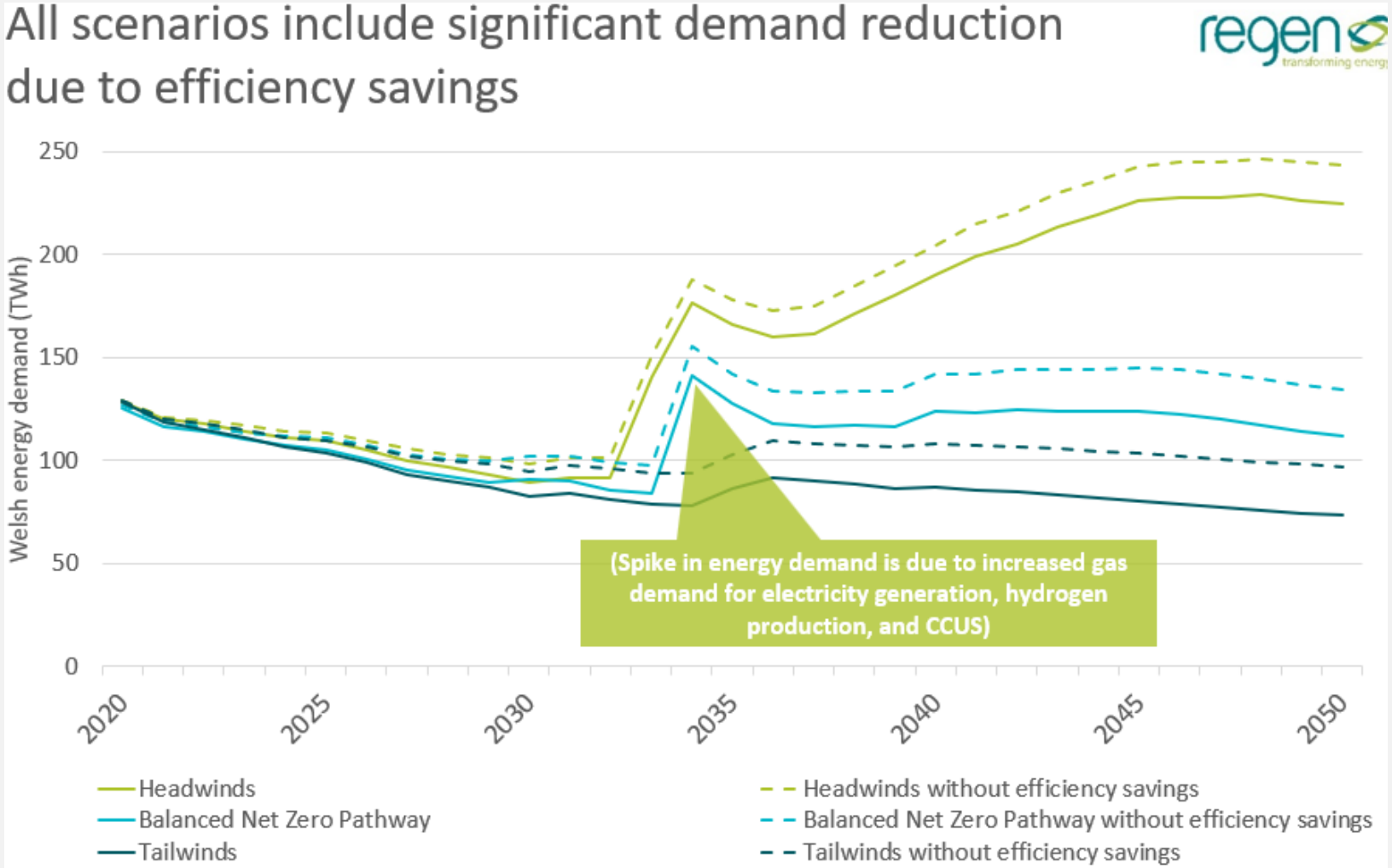


Figure 7: Future projections of Welsh energy demand. Three of the CCC's pathways are plotted alongside the projections for additional demand if efficiency savings are not realised.
Source: CCC 6th Carbon Budget; Regen analysis.

- All net zero CCC pathways include a reduction in energy demand of 18 to 24 TWh annually by 2050 due to efficiency savings.
- For the Balanced Pathway, CCC modelling shows efficiency savings reducing demand by 5.6 TWh in 2025 and up to 22.5 TWh in 2050.
- Efficiency savings are roughly the same in absolute terms for each of the scenarios.
- The demand scenarios modelled here do not include line losses.

CCC Welsh electricity efficiency impact trends

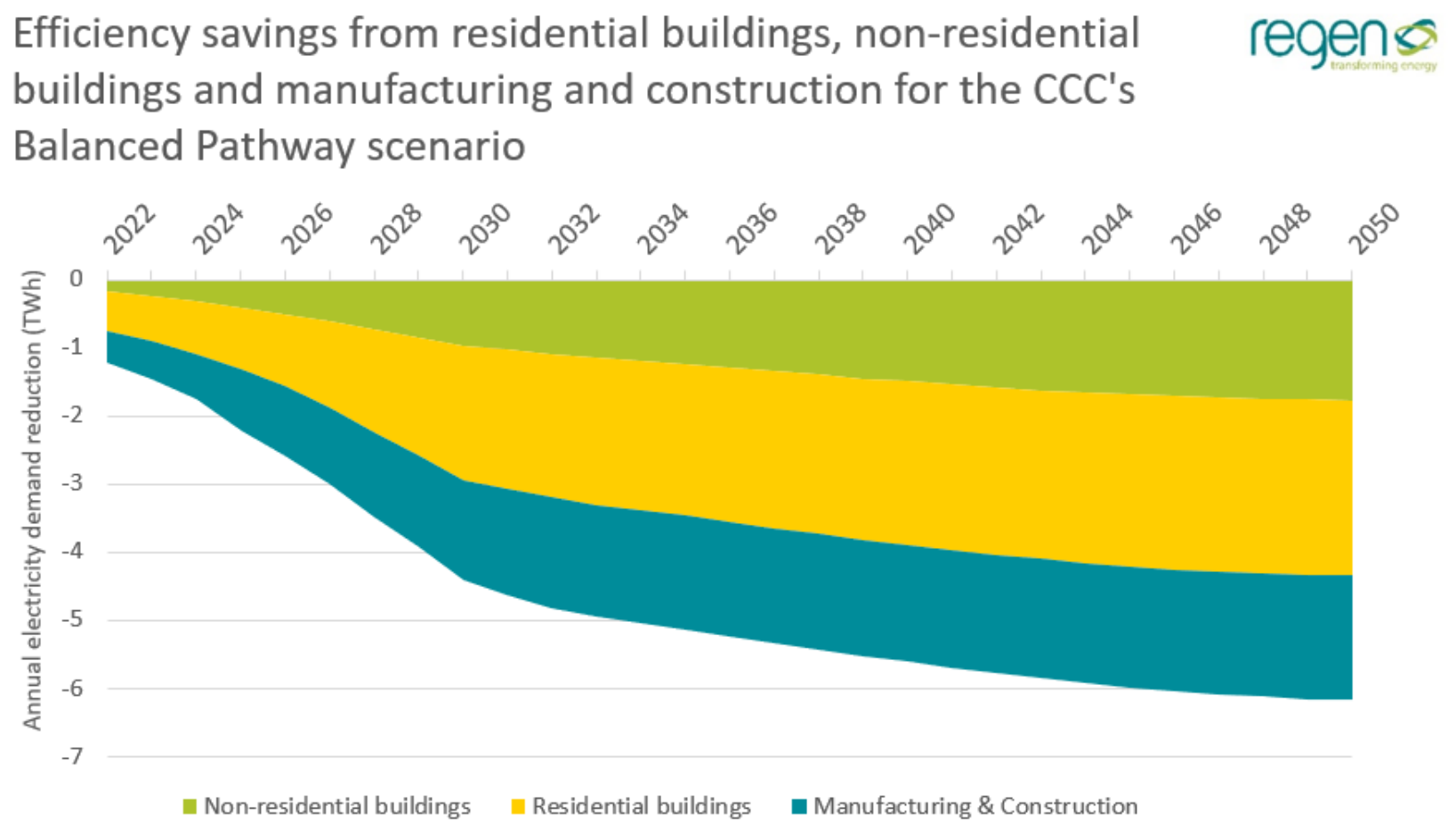


Figure 8: projected reduction in annual electricity demand due to efficiency savings from residential buildings, non-residential buildings and manufacturing and construction, taken from the CCC Balanced pathway scenario.
Source: CCC 6th Carbon Budget; Regen analysis.

- Almost half (44%) of efficiency savings in electricity demand are projected to come from the residential sector.
- A projected 53% of efficiency savings in electricity demand in the residential sector come from lighting and appliance efficiency, with the remainder attributable to fabric efficiency, fuel switching from gas to electricity for the provision of heat, and behaviour change.

Future Welsh electricity generation trends

FES and DFES electricity capacity trends

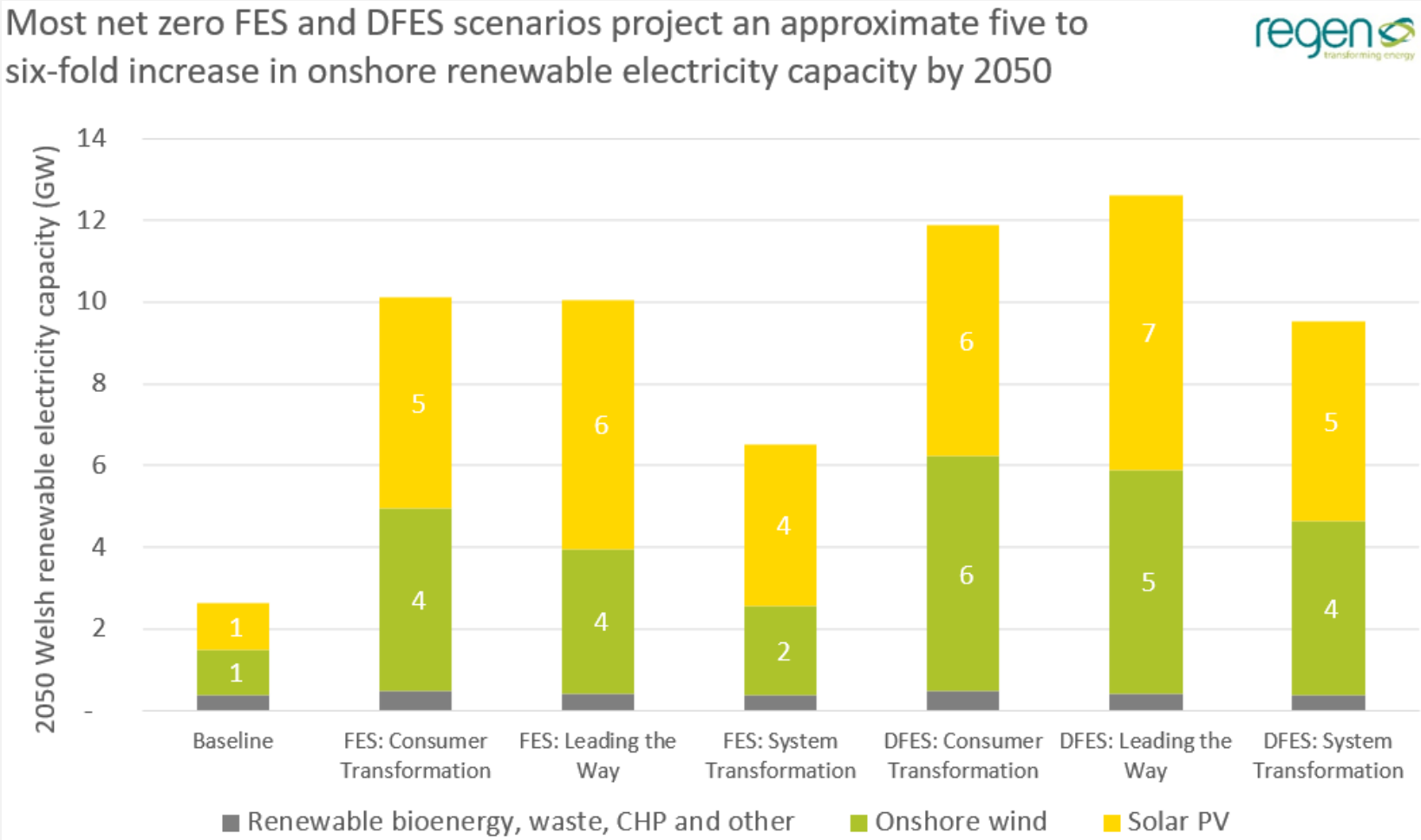


Figure 9: Baseline and future projections of total Welsh renewable electricity generation capacity.
Source: National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

- The National Grid ESO FES and electricity networks' DFES net zero scenario analysis identify high resource opportunities for the continued deployment of onshore wind and solar PV in Wales.
- A spatial allocation of offshore wind is not provided by the FES or DFES.
- The technology capacity projections do not equate to a technical cap or maximum resource projection for renewable electricity generation in Wales. Rather, they could be considered a product of two factors: (1) the amount of renewable electricity generation resources in Wales relative to the resources in the rest of Great Britain and (2) the total amount of renewable electricity generating capacity required for GB to achieve a net zero electricity system.

FES and DFES electricity generation trends (1)

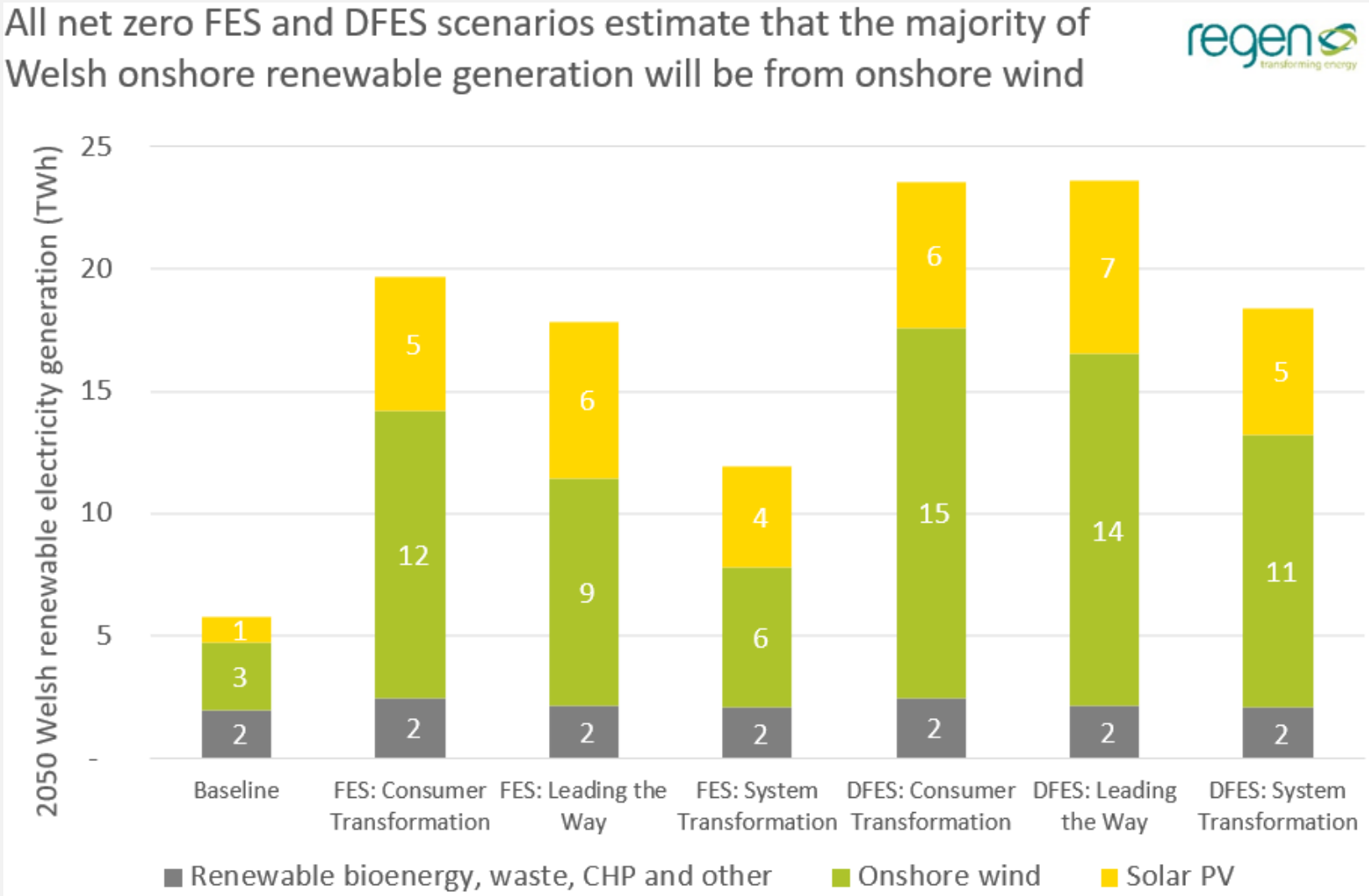


Figure 10: Baseline and future projections of annual Welsh renewable electricity generation.
Source: National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

- The National Grid ESO FES and electricity networks' DFES net zero scenario analysis identify high resource opportunities for the continued deployment of onshore wind and solar PV in Wales.
- A spatial allocation of offshore wind is not provided by the FES or DFES.

FES and DFES electricity generation trends (2)

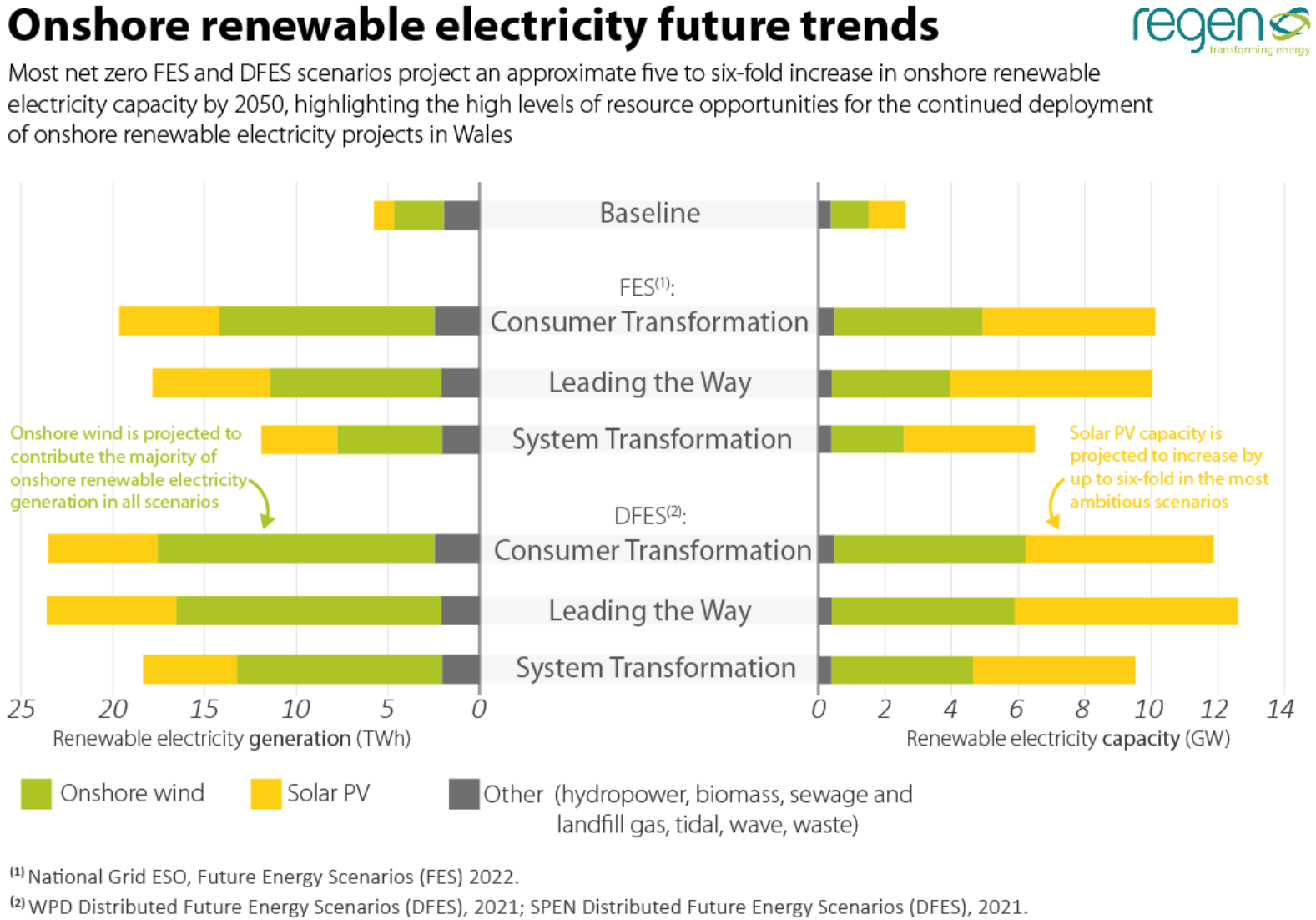


Figure 11: Baseline and future projections of annual Welsh renewable electricity generation.
Source: National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

- This graphic highlights the variance in renewable electricity technology capacity across different scenarios.
- While the scenarios often estimate there will be a similar amount of solar PV and onshore wind capacity – there is over twice as much renewable electricity generation projected from onshore wind than solar PV. This is because solar PV has an effective annual capacity factor of approximately 11% in Wales, while Welsh onshore wind has an effective annual capacity factor of 28%. This means that 1 MW of onshore wind will annually generate 2.5 times more renewable electricity than 1 MW of solar PV.

FES and DFES electricity generation trends (3)

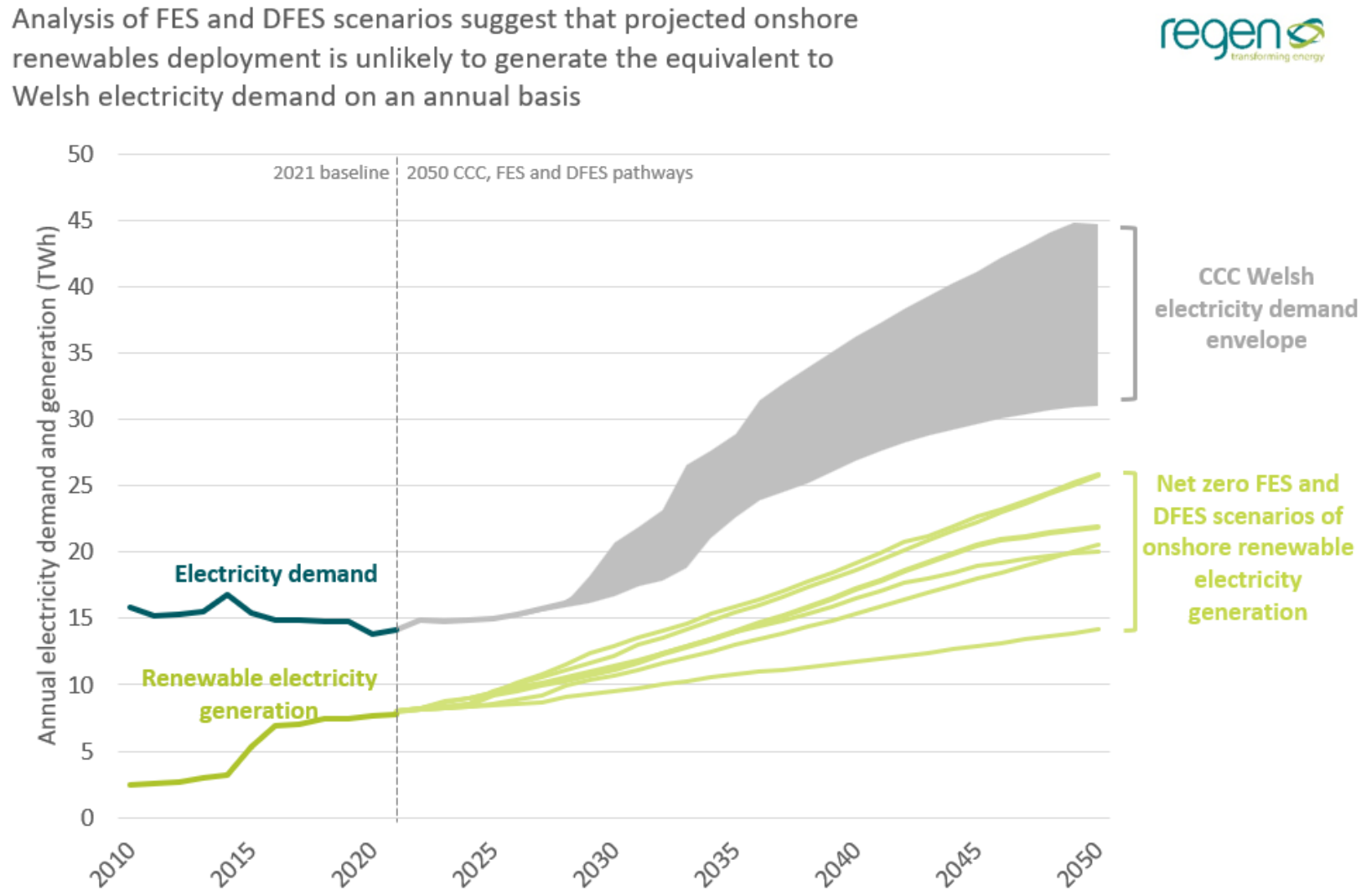


Figure 12: Baseline and future projections of annual Welsh renewable electricity generation.
Source: National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

- Analysis of FES and DFES scenarios suggest that projected onshore renewable deployment is unlikely to generate the equivalent to Welsh electricity demand on an annual basis.
- The FES and DFES technology capacity projections do not equate to a technical cap or maximum resource projection for renewable electricity generation in Wales.

Welsh renewable electricity trends (1)

The scale of offshore wind deployment off the Welsh coast could be critical to achieving energy targets

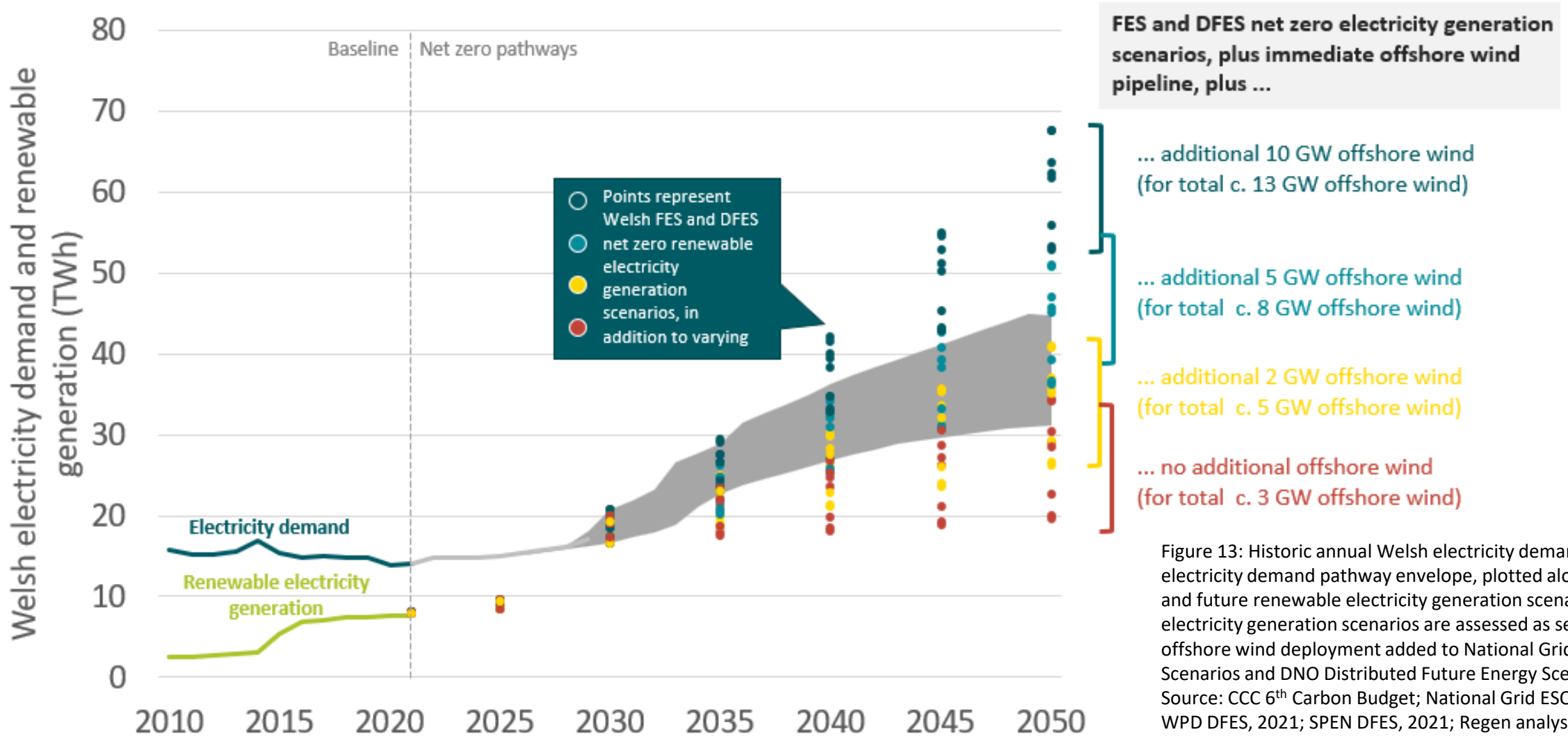
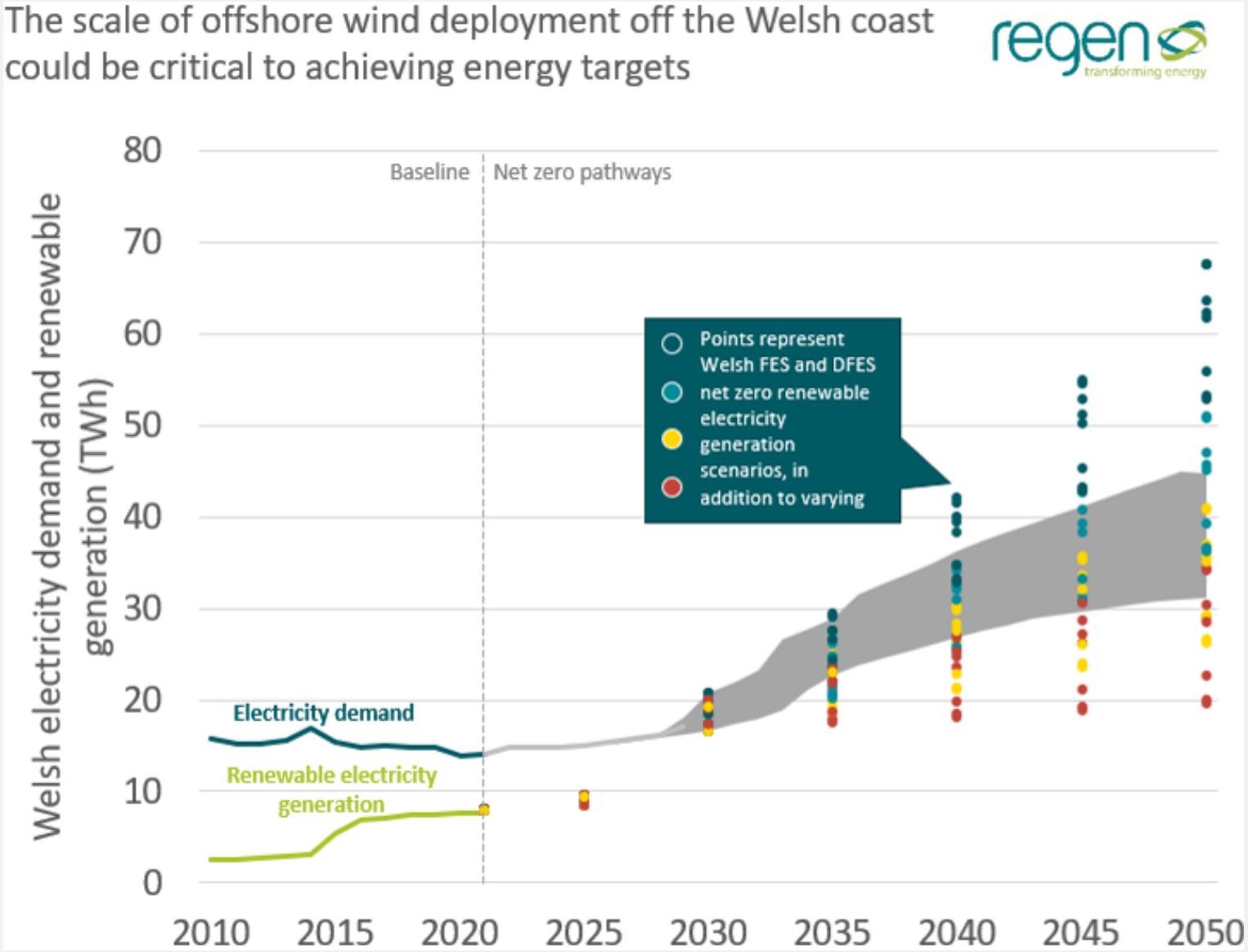


Figure 13: Historic annual Welsh electricity demand and CCC electricity demand pathway envelope, plotted alongside historic and future renewable electricity generation scenarios. Future electricity generation scenarios are assessed as sensitivities of offshore wind deployment added to National Grid Future Energy Scenarios and DNO Distributed Future Energy Scenarios.
Source: CCC 6th Carbon Budget; National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

Welsh renewable electricity trends (2)



Source: CCC 6th Carbon Budget; National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

- Analysis of FES and DFES net zero scenarios indicate that the deployment of Welsh offshore wind could be critical to Wales generating the equivalent amount of renewable electricity as the electricity Wales consumes on an annual basis.
- The immediate pipeline of potential offshore wind projects is assumed to include:
  - three 100 MW small-scale floating offshore wind projects in the Celtic sea (300 MW)
  - an extension to Gwynt y Mor (576 MW)
  - Mona offshore wind farm (1,500 MW)
- * These offshore wind farms are not guaranteed to be commissioned at this scale but are assumed to commission at this scale for illustrative purposes.
- There remains uncertainty as to how offshore wind can or should be spatially allocated to onshore geographic regions. Options include based on where the grid connection makes landfall, geographic proximity, supply chain, ownership or territorial waters.

Welsh renewable electricity pipeline

Welsh renewable electricity generation pipeline

Technology	Count of all projects analysed for inclusion in Welsh renewable electricity pipeline	Projects deemed active and included in Welsh renewable electricity pipeline		
		Count of projects	Total capacity (MW)	Estimated annual electricity generation (TWh)
Solar PV	66	43	1,097	1.1
Onshore wind	43	29	620	1.5
Offshore wind	5	5	2,476	5.4
Other	6	2	24	0.1
Total	**120**	**78**	**4,217**	**8.2**

Table 1: Identified pipeline renewable electricity projects in Wales.
Source: Regen analysis informed by analysis of NGED and SPEN Electricity Capacity Registers, BEIS Renewable Energy Planning Database, and developer website information.

- Over 4.2 GW of in-development renewable electricity projects have been identified.
- The primary data sources for this pipeline analysis were:
  - NGED and SPEN Embedded Capacity Register databases
  - BEIS Renewable Energy Planning Database
  - Developer websites
- Projects might be excluded from the pipeline for reasons including: unsuccessful planning applications or appeal, expired planning permission, not holding a grid connection, deemed project inactivity, deemed duplication, absence of planning records. Where possible, pre-development sites with long development timescales have been included, such as for offshore wind.

Welsh renewable electricity pipeline (1)

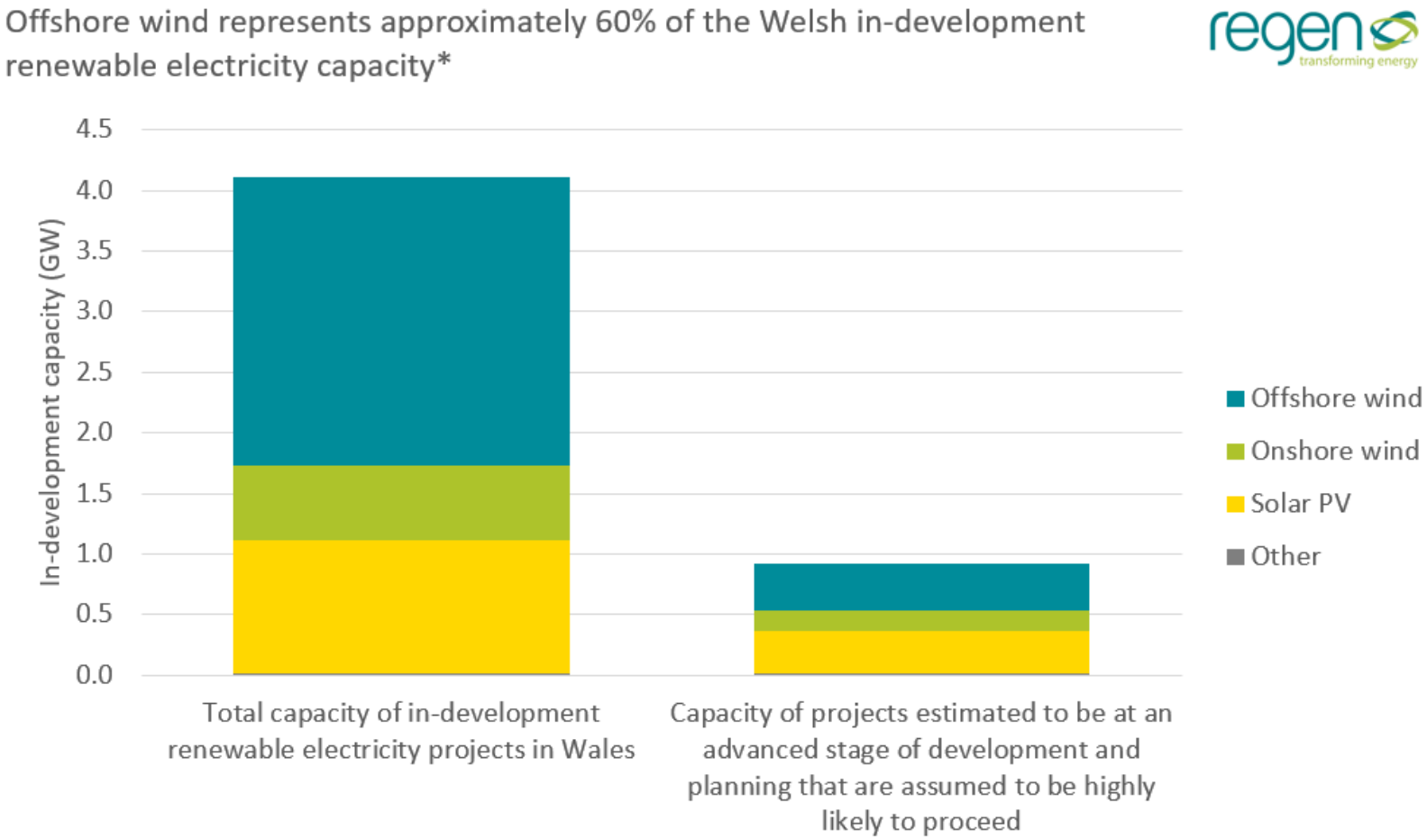


Figure 14: Identified pipeline renewable electricity projects in Wales, including an estimation of their development status.
Source: Regen analysis informed by analysis of NGED and SPEN Electricity Capacity Registers, BEIS Renewable Energy Planning Database, and developer website information.

- The identified pipeline of projects is dominated by offshore wind, with nearly 2.4 GW of in-development projects, including two projects in planning. The largest in-development project is the (up to) 1.5 GW Mona offshore wind farm.
- Less than 1 GW of the in-development projects are deemed to be at an advanced stage of planning and development.
- Due to the extended development timescales for onshore wind, there is a narrowing window of time for onshore wind to begin develop and commission before 2030.

The route to 2030

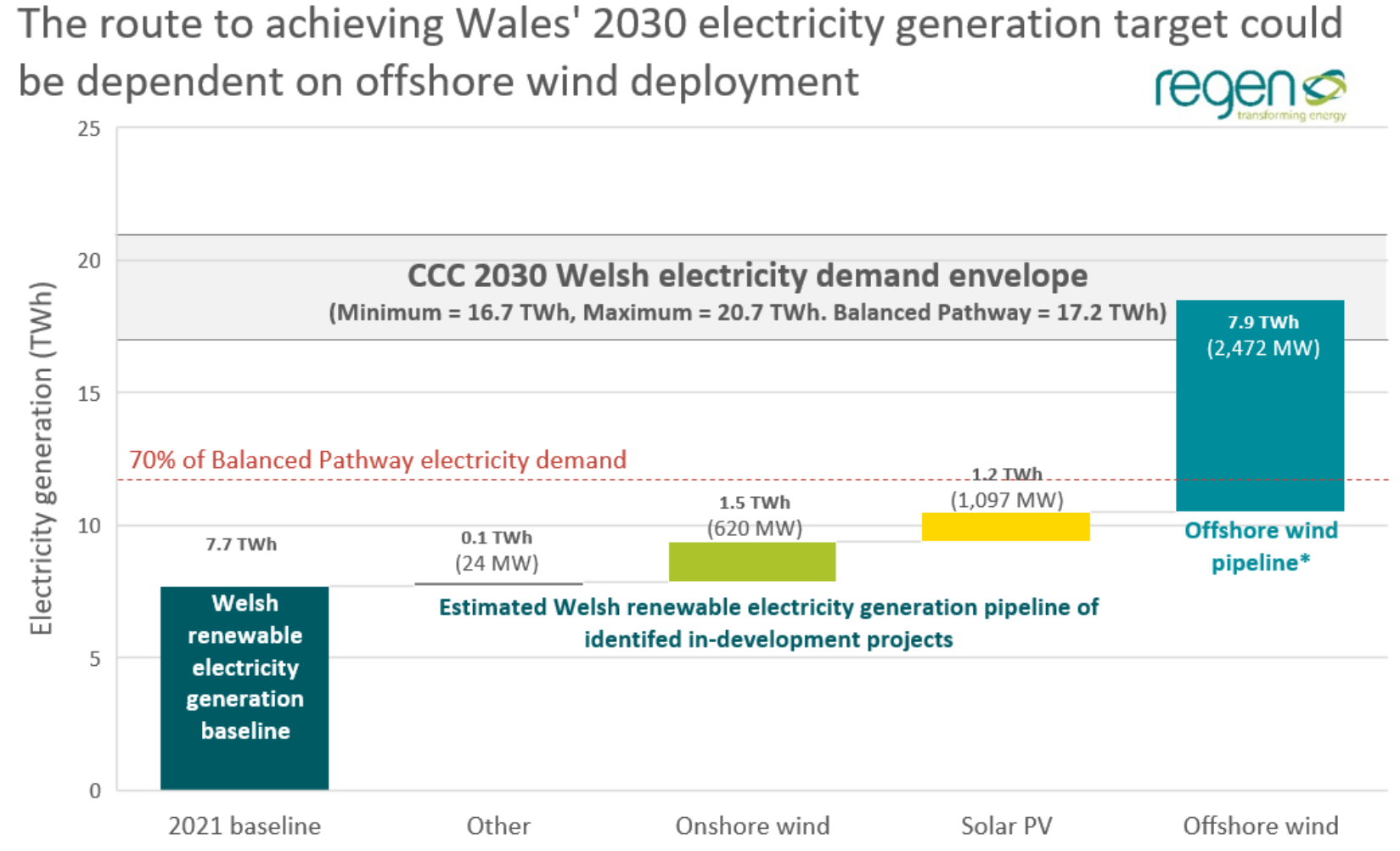


Figure 15: Existing annual Welsh renewable electricity generation pipeline relative to 2030 70% electricity generation target, in addition to an illustrative offshore wind pipeline. Other includes bioenergy, marine, hydro and waste.
Source: CCC 6th Carbon Budget; National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

- Analysis of the pipeline of in-development projects indicates that the deployment of Welsh offshore wind could be critical to achieving the 2030 70% target, and particularly to going beyond 70%.
- The immediate pipeline of potential offshore wind projects is assumed to include:
  - three 100 MW small-scale floating offshore wind projects in the Celtic sea (300 MW)
  - an extension to Gwynt y Mor (576 MW)
  - Mona offshore wind farm (1,500 MW)
- * These offshore wind farms are not guaranteed to be commissioned at this scale but are assumed to commission at this scale for illustrative purposes.

Welsh renewable electricity pipeline (2)

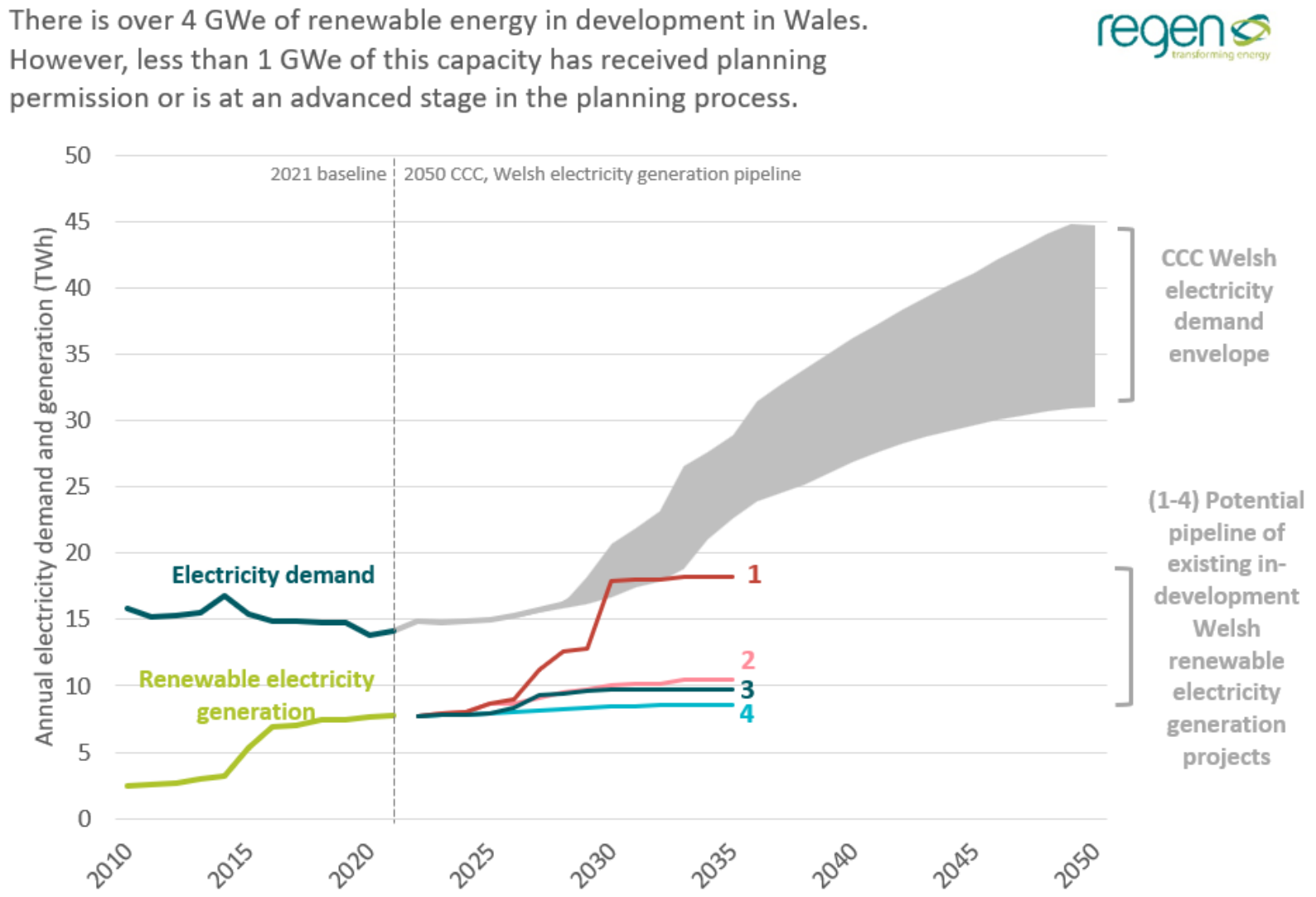


Figure 16: Welsh renewable electricity project pipelines
Source: 6th Carbon Budget, CCC, 2019. Energy Generation in Wales, Welsh Government, 2021. Regen analysis.

Pipeline pathways:

1. All onshore and offshore in-development electricity generation projects in Wales, including onshore and offshore technologies.
2. Onshore and offshore electricity generation projects in Wales that have received planning permission and are presently active or at an advanced stage of gaining planning permission.
3. All onshore in-development electricity generation projects in Wales.
4. Onshore electricity generation projects in Wales that have received planning permission and are presently active or are at an advanced stage of gaining planning permission.

Key observations arising from the analysis of Wales' electricity generation pipeline:

- If onshore and offshore wind projects experience the same development timescale as historic trends, there are unlikely to be wind projects commissioning before 2030 that are not presently already in-development.
- If 100% of the in-development on- and off-shore renewable electricity generation projects in Wales are commissioned, estimated Welsh renewable electricity generation is approximately the same as the CCC's Balanced pathway electricity demand estimate for 2030.
- There are insufficient onshore renewable projects in-development to meet Wales' 2030 electricity generation target.
- Achieving Wales' electricity generation target is presently highly reliant on the successful development of most of Wales' existing in-development offshore wind projects.

A route to 2035

An illustrative route to a 100% 2035 target (1)

	Baseline Welsh 2021 renewable electricity		Illustrative Welsh 2035 renewable electricity		Percentage increase in capacity
	Capacity (MW)	Generation (TWh)	Capacity (MW)	Generation (TWh)	
Hydropower, biomass CHP, marine, waste and other	382	1.4	697	2.4	82%
Large-scale onshore wind	1,186	2.9	2,505	6.2	111%
Small-scale onshore wind	69	0.2	201	0.5	191%
Large-scale solar PV	752	0.7	2,392	2.3	218%
Small-scale solar PV	264	0.2	983	1.0	273%
Offshore wind	726	2.2	5,198	16.5	616%
Total	**3,379**	**7.7**	**11,976**	**29.0**	**254%**

Table 2: Illustrative 2035 Welsh renewable electricity generation, by technology and scale, required to achieve generating the equivalent of 100% of Welsh electricity demand from Welsh renewable electricity capacity. The 2035 Welsh renewable electricity illustration is analysed as comprising the Welsh renewable electricity baseline, plus all active and in-development pipeline projects identified through Regen analysis, plus further projections out to 2035 informed by FES and DFES analysis alongside market analysis by Regen. Small-scale/large-scale projects are defined as <1MW/>1MW for onshore wind and solar PV.
Source: Regen analysis. National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021.

- Onshore renewable electricity generation projections for 2035 (onshore wind, solar PV, renewable bioenergy, waste, CHP and other) are taken as the average of the FES and DFES net zero scenario projections.
- Offshore wind projections are not detailed spatially in the FES and are not included in the higher granularity and lower voltage DFES analysis. Therefore, the offshore wind pipeline and projection has been analsyed by Regen and is informed by offshore wind projects that are presently in development, in addition to stated Crown Estate ambitions for Celtic sea development until 2035.

An illustrative route to a 100% 2035 target (2)

A route to 2035

Although Wales has the renewable energy resources to achieve more, the below is an illustrative route for Wales to generate the equivalent of 100% of its electricity demand from renewable electricity sources in 2035

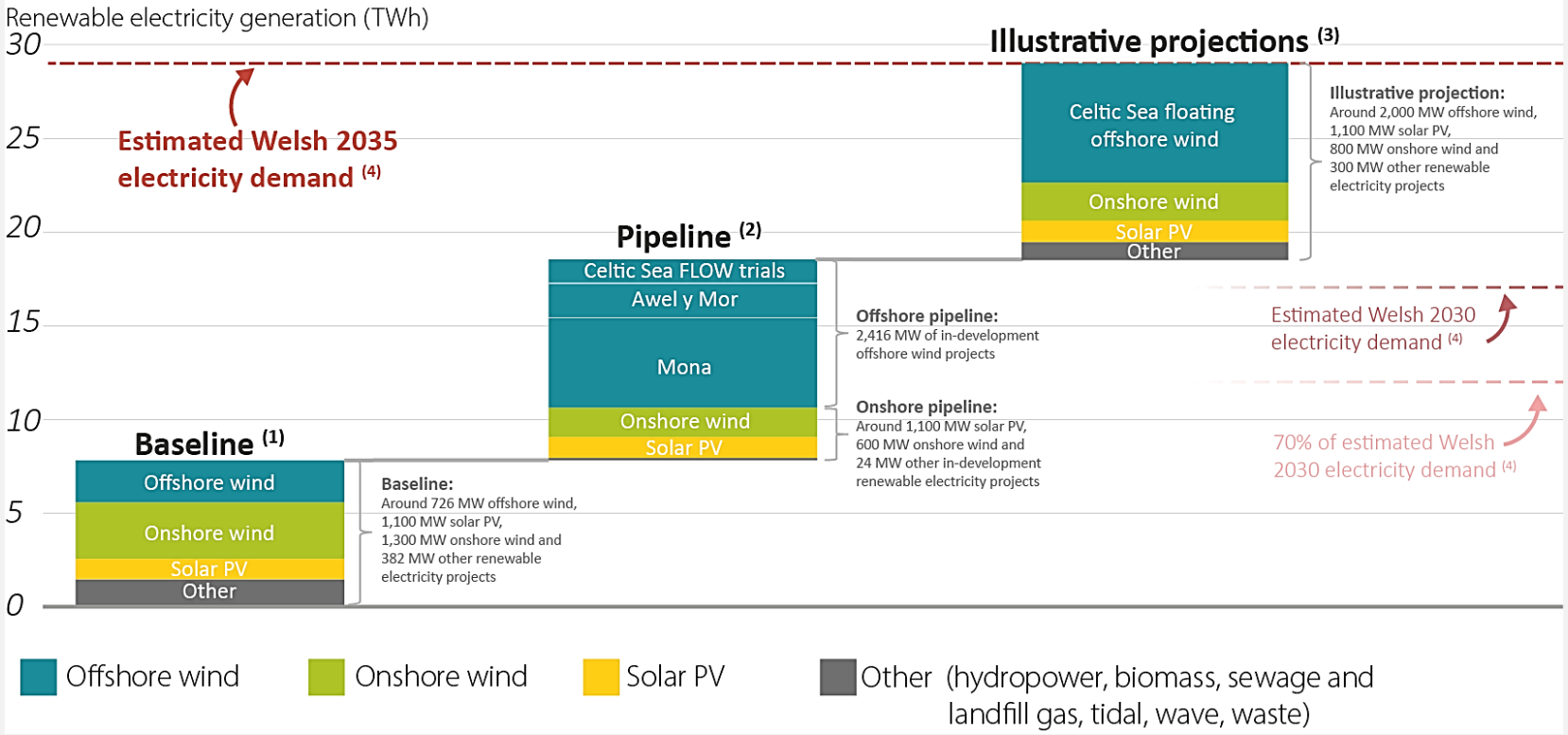


Figure 17: Illustrative 2035 Welsh renewable electricity generation, by technology and status, required to achieve generating the equivalent of 100% of Welsh electricity demand from Welsh renewable electricity capacity. The 2035 Welsh renewable electricity illustration is analysed as comprising the Welsh renewable electricity baseline, plus all active and in-development pipeline projects identified through Regen analysis, plus further projections out to 2035 informed by FES and DFES analysis alongside market analysis by Regen.
Source: Regen analysis. National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; CCC 6th Carbon budget, 2019.

- (1) Welsh renewable electricity generation in 2021. Source: Welsh Government, Energy Generation in Wales, 2020.
- (2) Renewable electricity generation projects identified as active and in-development in Wales. Source: Regen analysis: National Grid ECR, SPEN ECR, BEIS REPD, developer websites.
- (3) Illustrative projection of renewable electricity projects (beyond the identified project pipeline) to reach 100% 2035 target. Source: Regen analysis of National Grid and SPEN DFES data and offshore wind market analysis. An assumption is made that half of the 4 GW Crown Estate Celtic Sea leasing round ambition is assigned to Wales.
- (4) Estimated Welsh electricity demand increases from c. 14 TWh in 2022 to c. 26 TWh in 2035, plus 9% transmission losses = c. 29 TWh. Source: CCC 6th Carbon Budget Balanced Pathway, 2019.

An illustrative route to a 100% 2035 target (*capacity*)

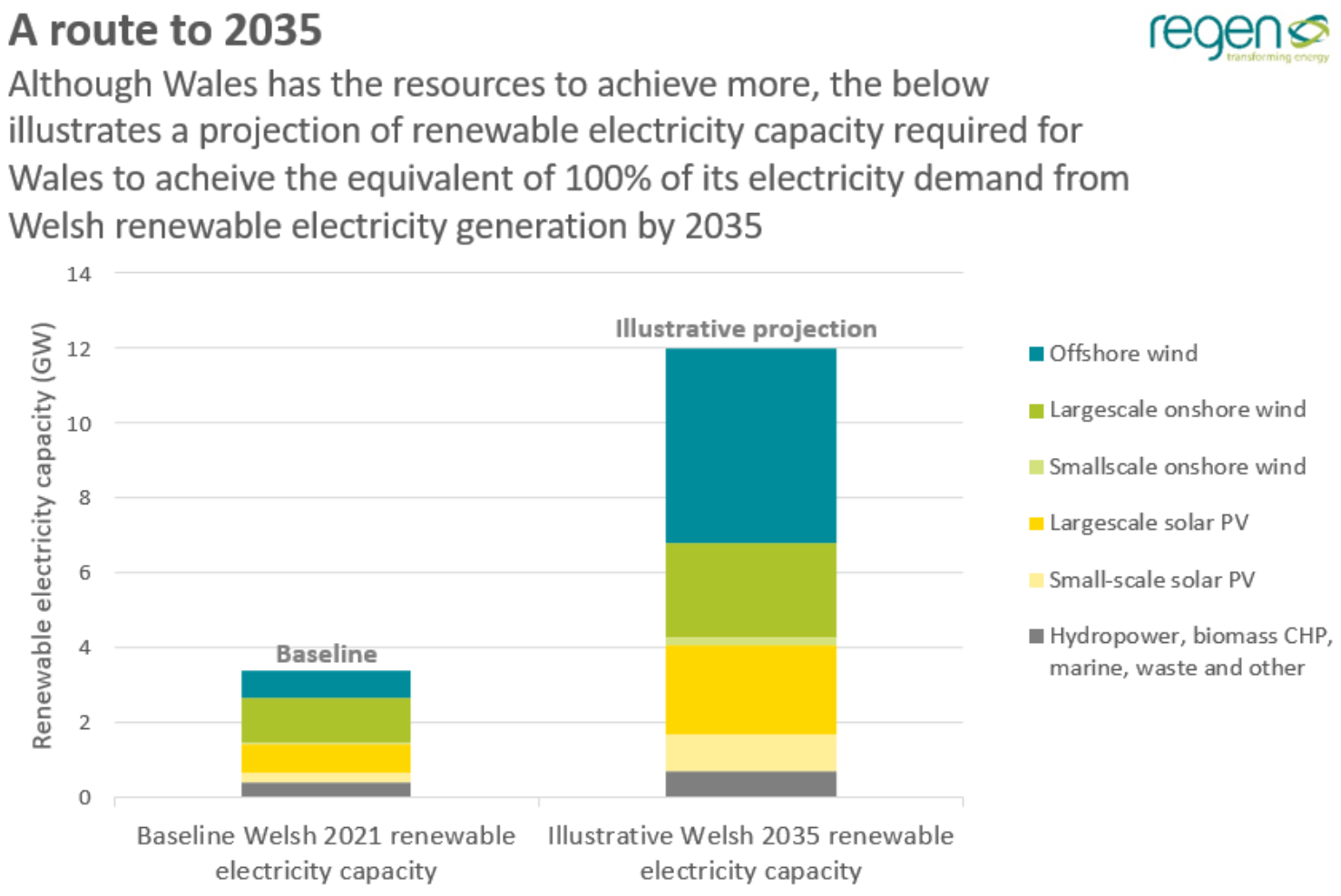


Figure 18: Illustrative annual Welsh renewable electricity capacity, by technology and scale, required to achieve generating the equivalent of 100% of Welsh electricity demand from Welsh renewable electricity capacity. The 2035 Welsh renewable electricity illustration is analysed as comprising the Welsh renewable electricity baseline, plus all active and in-development pipeline projects identified through Regen analysis, plus further projections out to 2035 informed by FES and DFES analysis alongside market analysis by Regen.
Source: Regen analysis. National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; CCC 6th Carbon budget, 2019.

- To achieve generating the equivalent of 100% of Welsh electricity demand from Welsh renewable electricity capacity could require (collectively):
  - onshore wind capacity more than doubled by 2035 compared to the 2021 baseline
  - solar PV capacity to more than triple by 2035, compared to the 2021 baseline.
  - offshore wind capacity to increase more than seven-fold.
- There is currently 2.5 GW of offshore wind in development near the Welsh coastline and whose grid connection could make landfall in Wales. Therefore, this illustrative 2035 offshore wind projection assumes that an additional c. 2 GW of offshore wind will commission beyond the in-development pipeline. This is equivalent to half of the Crown Estate's 4 GW floating offshore wind ambition for the Celtic Sea by 2035.

An illustrative route to a 100% 2035 target (*generation*)

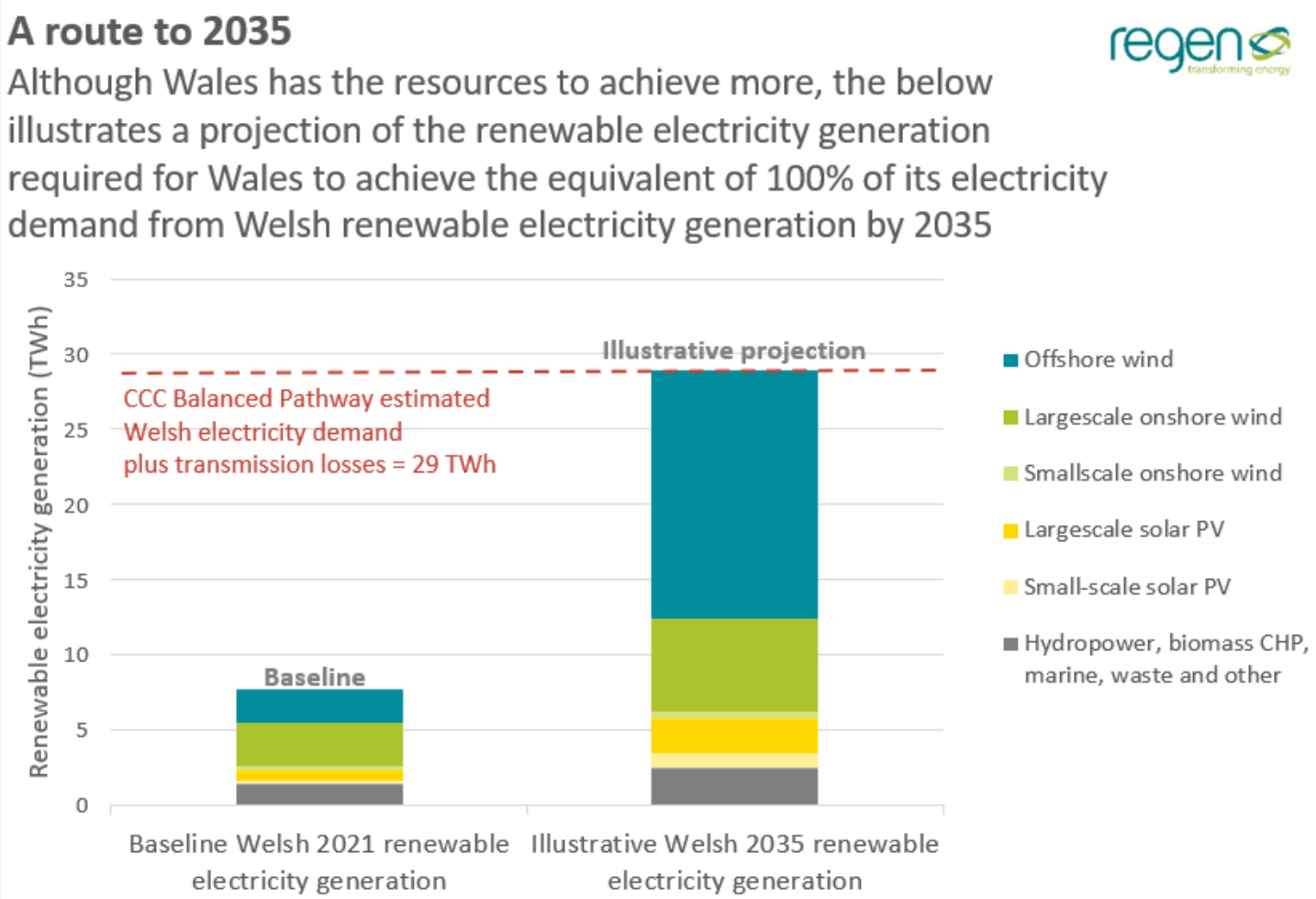


Figure 19: Illustrative 2035 Welsh renewable electricity generation, by technology and scale, required to achieve generating the equivalent of 100% of Welsh electricity demand from Welsh renewable electricity capacity by 2035 . The 2035 Welsh renewable electricity illustration is analysed as comprising the Welsh renewable electricity baseline, plus all active and in-development pipeline projects identified through Regen analysis, plus further projections out to 2035 informed by FES and DFES analysis alongside market analysis by Regen.
Source: Regen analysis. National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; CCC 6th Carbon budget, 2019.

- Wales' abundant renewable energy resources are more than sufficient to match or exceed future projections of electricity demand. However, this graphic illustrates the generation that could be required by technology to achieve the specific goal of generating the equivalent of 100% of Welsh electricity demand from Welsh renewable electricity capacity.
- Onshore and offshore wind are projected to contribute the majority of Welsh renewable electricity generation.
- Largescale renewables are projected to contribute 90% of renewable electricity generation in Wales.
- Hydropower, biomass CHP, marine, waste and other renewable electricity generation technologies are projected to contribute over 5% of total Welsh renewable electricity generation.

Other

Small-scale renewable energy projections

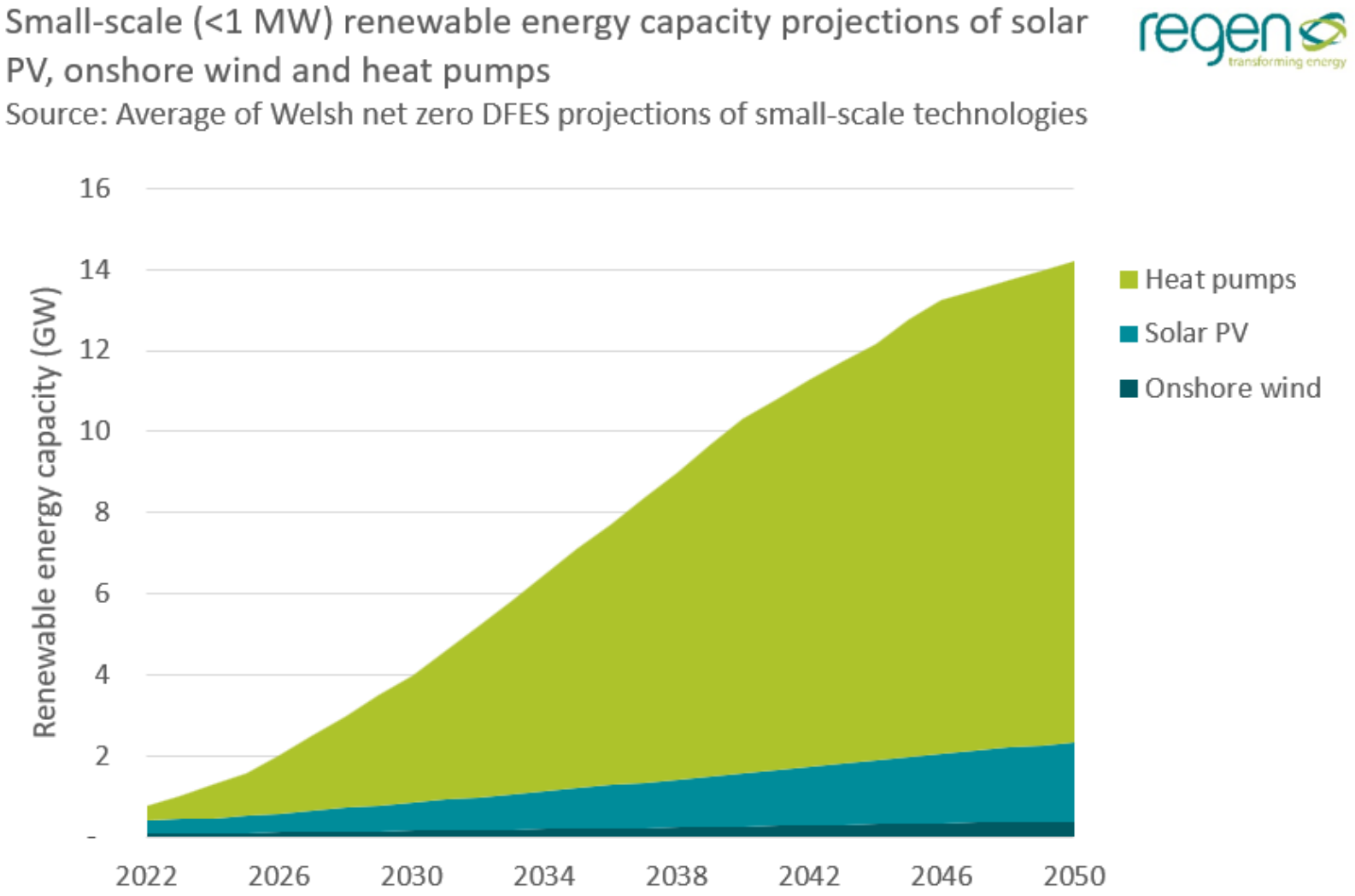


Figure 20: Small-scale renewable energy capacity projections, including solar PV, onshore wind and heat pumps. Assumes the average small-scale heat pump is $10kW_{thermal}$.
Source: National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

- At present, 62% locally owned renewable energy is small-scale (<1 MW), while 38% is large-scale (>1 MW)
- Analysis of FES and DFES projections has been used to illustrate small-scale solar PV, onshore wind and heat pump capacity uptake.
- Other renewable energy technologies will contribute to a renewable energy local ownership target, such as biomass and solar thermal. However, solar, wind and heat pumps are the only renewable energy technologies for which small-scale uptake projections were available from the FES and DFES.
- The Welsh DFES net zero scenarios project, on average, approximately 589,000 heat pumps in Wales by 2035, assumed to be equivalent to approximately 5.9 $GW_{thermal}$ .This compares to approximately 582,000 heat pumps in the CCC's Balanced pathway.

Small-scale renewable electricity projections (1)

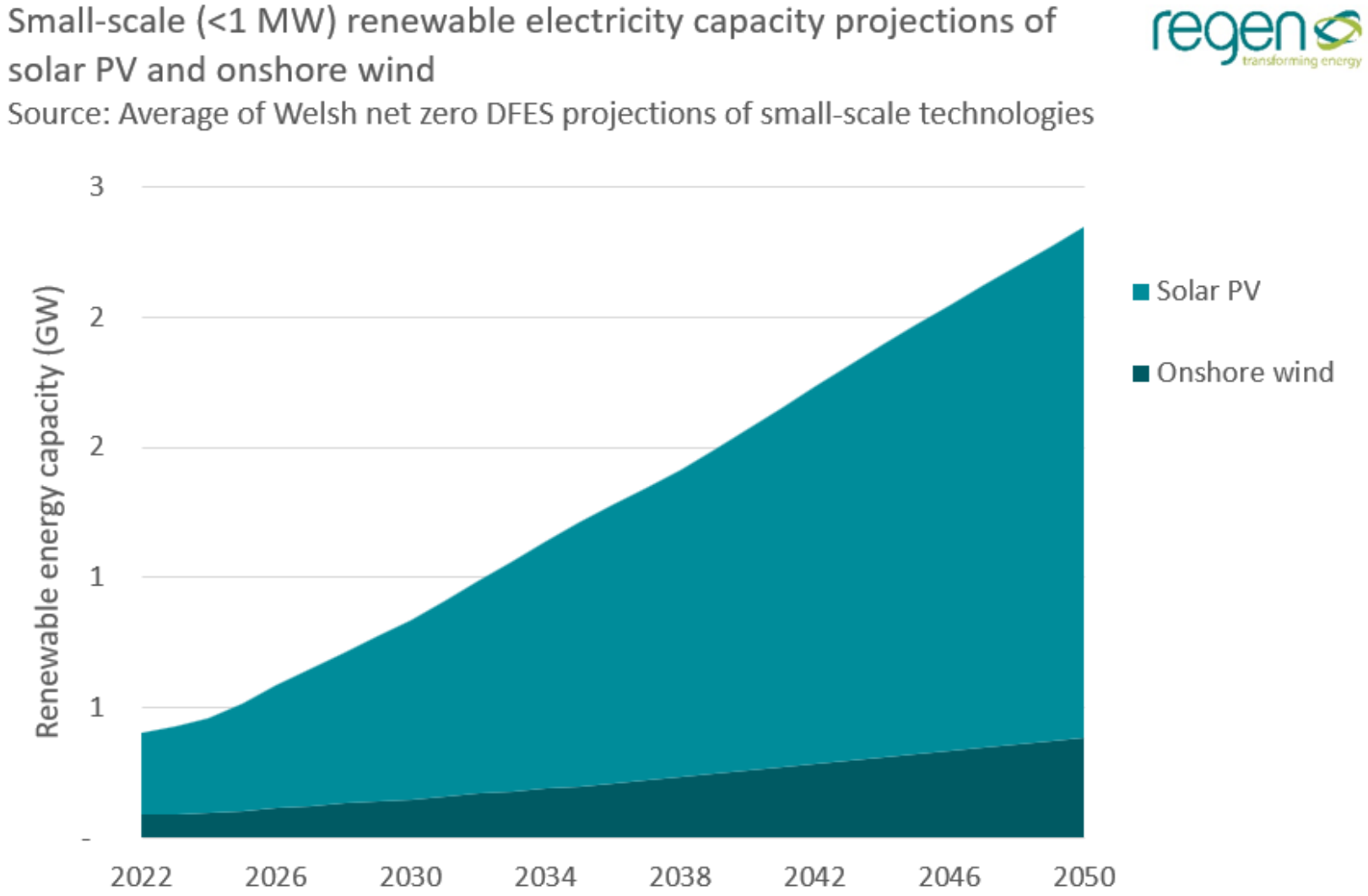


Figure 20: Small-scale renewable energy capacity projections, including solar PV, onshore wind and heat pumps. Assumes the average small-scale heat pump is $10kW_{thermal}$.
Source: National Grid ESO, FES 2022; WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

- At present, 62% locally owned renewable energy is small-scale (<1 MW), while 38% is large-scale (>1 MW)
- Analysis of FES and DFES projections has been used to illustrate small-scale solar PV and onshore wind and capacity uptake.
- Other renewable energy technologies will contribute to a renewable electricity local ownership target, such as hydropower. However, solar and wind are the only renewable energy technologies for which small-scale uptake projections were available from the FES and DFES.

Small-scale renewable energy projections (2)

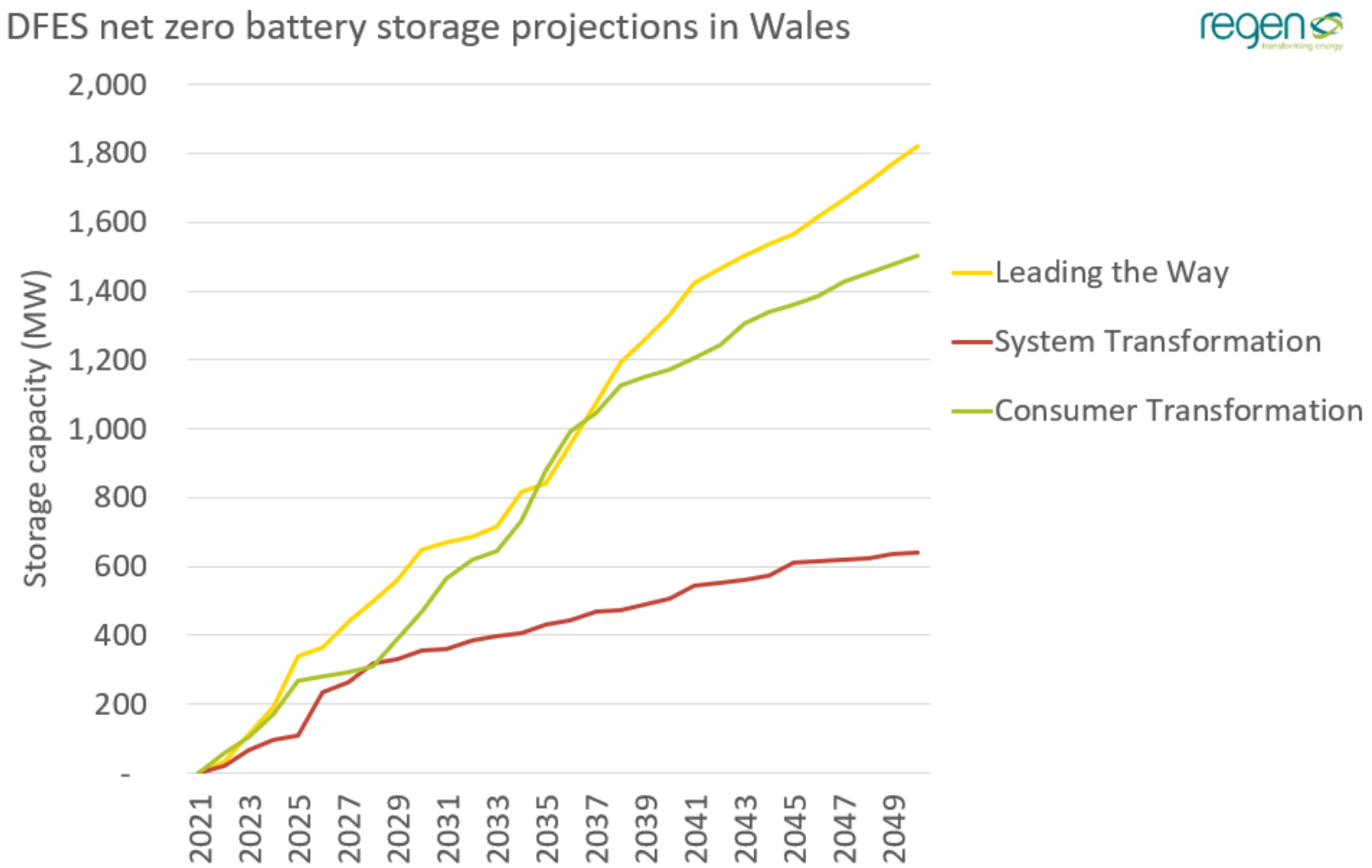


Figure 21: Battery storage uptake projections by net zero DFES scenario
Source: WPD DFES, 2021; SPEN DFES, 2021; Regen analysis.

- Leading the Way, System Transformation and Consumer Transformation are National Grid ESO's net zero scenarios in the Future Energy Scenarios publication.
- The Distributed Future Energy Scenarios for Wales use the same scenario framework and estimate that battery storage in Wales could reach over 1.8 GW by 2050.

Repowering (1)

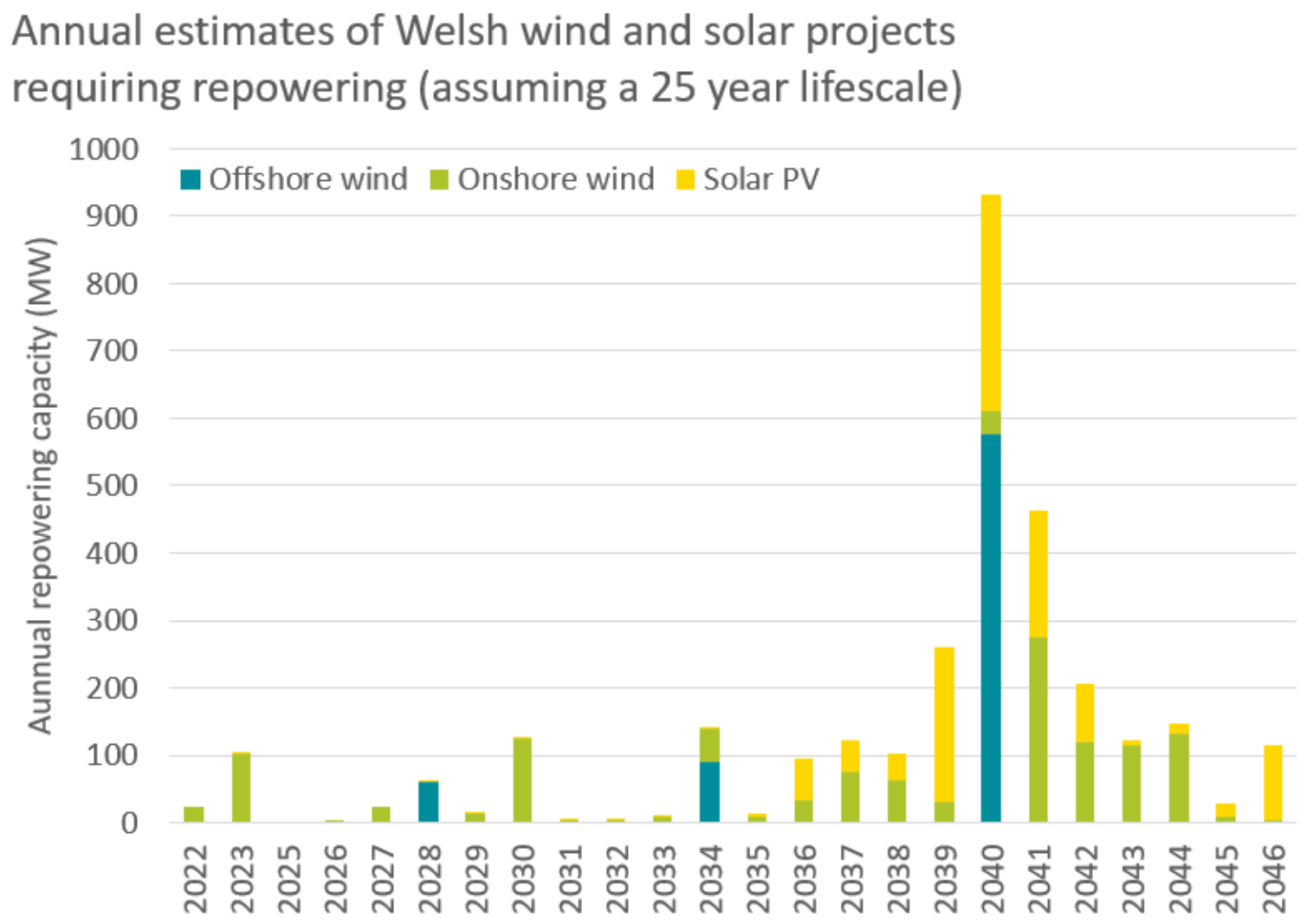


Figure 22: Annual estimates of Welsh wind and solar projects that could require repowering, assuming a 25 year lifecycle.
Source: Energy Generation in Wales 2021, Welsh Government; Regen analysis.

- In 2015, over 900 MW of onshore wind, offshore wind and solar PV was commissioned. Assuming a lifecycle of approximately 25 years, in 2040 in the order of 900 MW of wind and solar could be due for decommissioning, repowering or life extension works.
- While there isn't a legacy of solar PV project repowering due to their relative infancy, many onshore wind projects have 'repowered' or 'recommissioned' in Wales and across the UK. Wind projects tend to repower with fewer turbines than their predecessors, but with larger turbines leading to greater total capacity. This means that some of the additional capacity required to meet future energy targets could be met on existing sites – if they are repowered rather than decommissioned.

Repowering (2)

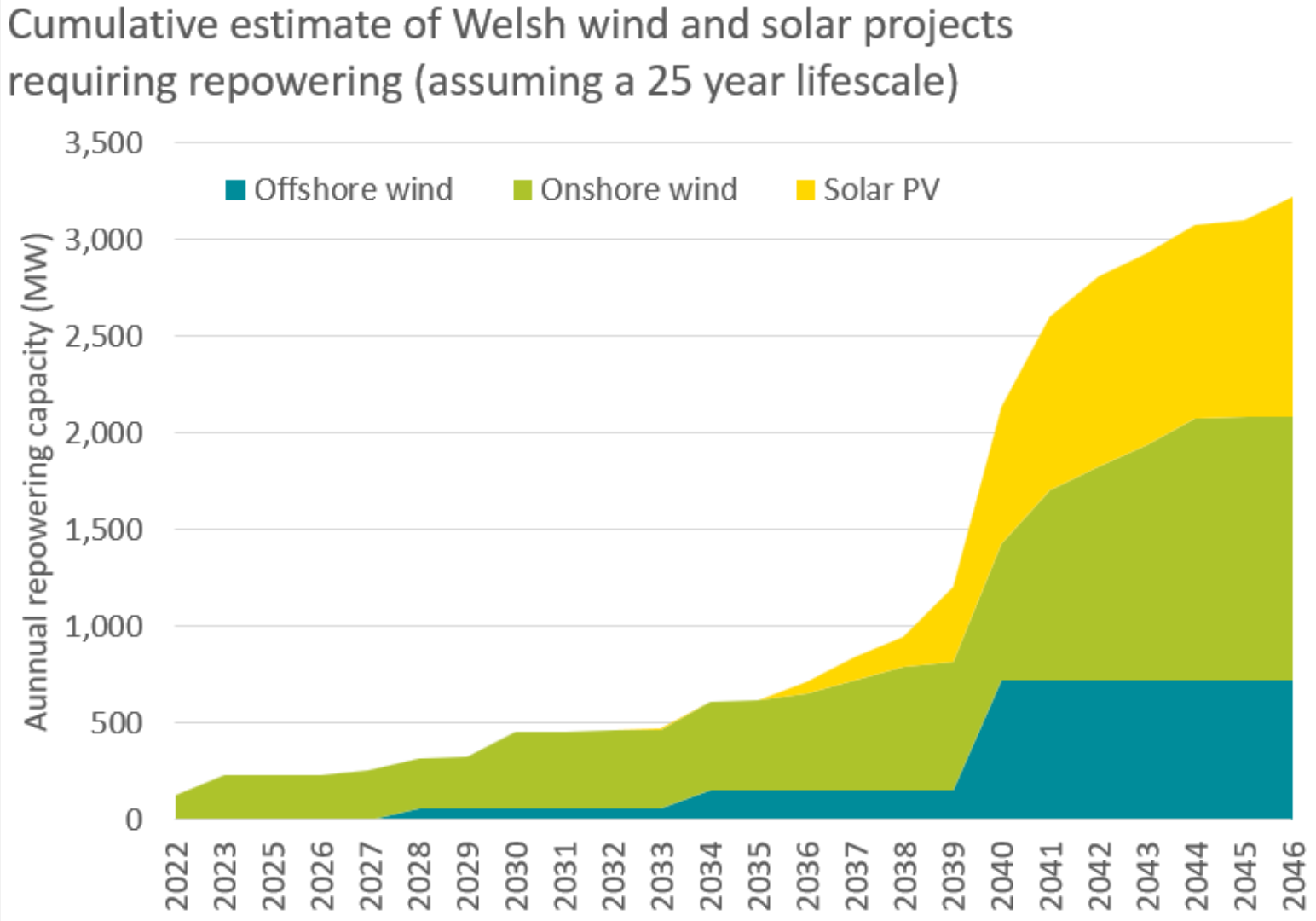


Figure 23: Cumulative estimates of Welsh wind and solar projects that could require repowering, assuming a 25 year lifecycle.
Source: Energy Generation in Wales 2021, Welsh Government; Regen analysis.

- By 2035, in the order of 600 MW of onshore and offshore wind projects could require repowering or life extension works, assuming an operating lifecycle of 25 years.
- The first largescale Welsh solar PV projects were commissioned in 2011-2012. Assuming a typical lifecycle of 25 years, it's possible that few solar PV sites will require recommissioning prior to 2035. Nearly 80% of Welsh solar PV projects were commissioned between 2013 and 2017, meaning that there could be a rush of repowering or life extension activities for existing solar projects in the late 2030s and early 2040s.
- There is uncertainty as to when sites will repower in the future, so 25 years is used as an assumption based on past trends of onshore wind, and on the length of time renewable energy sites often have planning permission for. Sites could repower or life extend before or after this time depending on the policy environment and technology developments, impacting the timescale of repowering illustrated in this graph.

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