National Heat Study

Net-zero by 2050

Scenario descriptions and high-level input assumptions

seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

How to get to zero?

Baseline

The baseline scenario, or **‘business as usual’ case**, shows the most likely development of energy demand, supply and transformation based on current knowledge, technological development and policy measures.

Decarbonised Gas

Policy supports **expansion of the gas grid**, implementation of **CCS/BECCS in power and industry**, the production of **green hydrogen**, and maximising **additional AD resources**.

District heating limit of 10% of heating demand in buildings.

High Electrification

Policy supports the **uptake of heat pumps** alongside uptake of **energy efficiency**, **electricity network reinforcement**, and maximising **perennial energy crops**; the gas network extent reduced. **District heating limit of 30%** of heating demand in buildings.

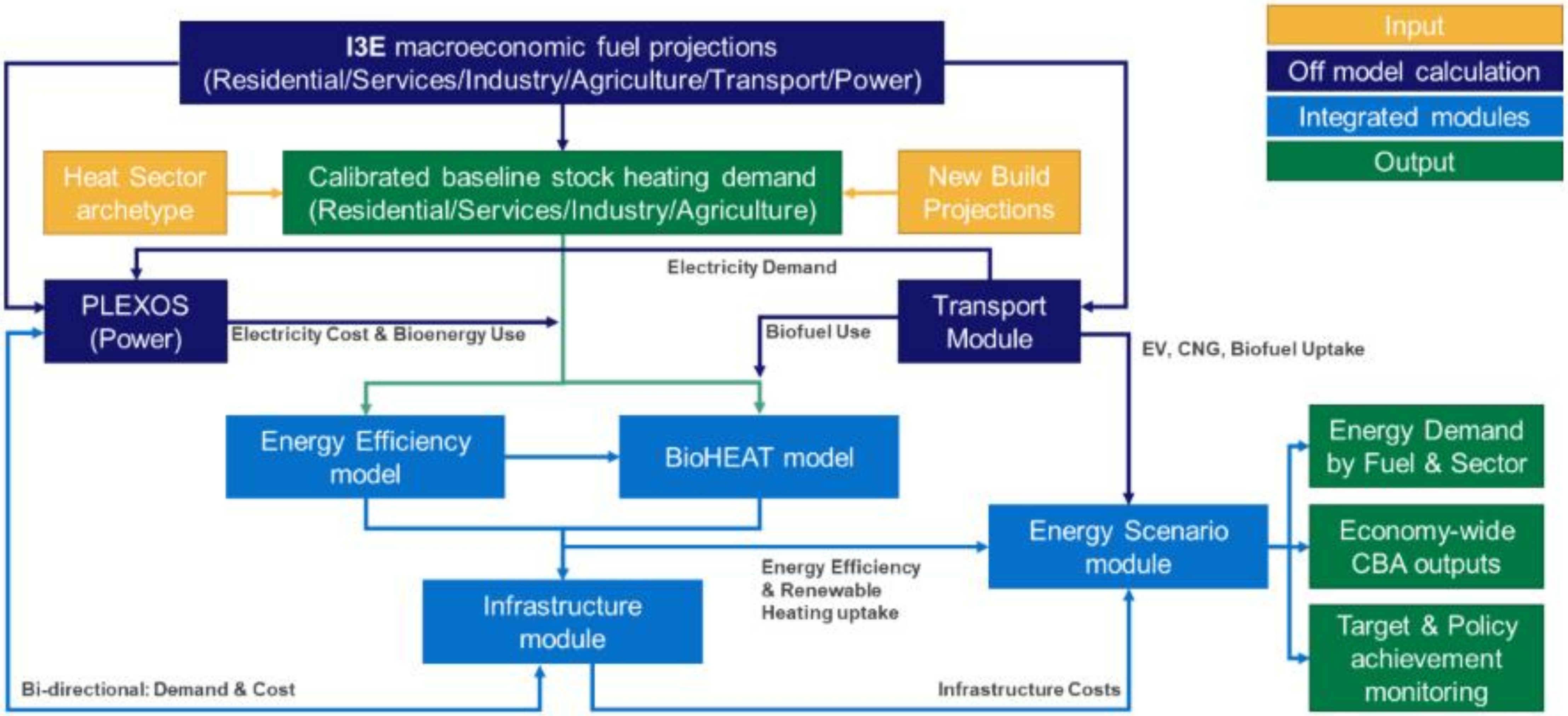
Balanced

Diverse policy flexibly supports **electrification** alongside use of **green hydrogen and biomethane,** implementation of **CCS/BECCS in power and industry**, and a mix of additional AD resources and perennial energy crops. **District heating limit of 20%** of heating demand in buildings.

Rapid Progress

Immediate and diverse policy supports **electrification in the near-term** alongside the increased use of **biomethane** in the **gas grid,** implementation of **CCS/BECCS in power and industry**, and maximising AD resources. **District heating limit of 30%**.

National Energy Modelling Framework (NEMF) Schematic



Scenario modelling framework & assumptions

All scenarios are formed using the same per-unit base assumptions and modelling framework.

- **Base assumptions (per-unit)** are those which **do not change between scenarios**. These may include:
  - Resource / direct combustion emissions (kgCO_2e/kWh)
  - Technology costs (fixed € and marginal €/kW)
  - Energy efficiency measure costs (€/measure)
  - Energy efficiency measure savings (kWh/measure)*
  - Energy service demand (kWh demand / archetype, total useful energy demand)*

  * The level of energy efficiency deployment and thus resulting scenario-wide savings will be different across scenarios based on the varied scenario uptake of different levels of energy efficiency packages. As such, the baseline useful energy demand (AKA energy service demand) will remain constant while the required final energy demand will vary.

- To achieve different scenario outputs, other varying assumptions and modelling methodologies are leveraged:
  - Availability of certain technologies or fuel *(dictated by scenario narrative)*
  - Grant and other policy incentives
  - Fossil fuel phase-out dates
  - Level of CCUS
  - Limit for district heating
  - Radiator costs
  - Timeline for inclusion of laggards
  - Resource availability
  - Turnover rates

Scenario input variation

Category	Baseline	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Residential	- Low amounts (all) biomethane blended into the grid - No H2 techs. - No in-fill gas grid connections - Solid biomass & bioliquid available off grid (elec. CF cannot switch to this) - No elec. resistive/storage on-grid	- Biomethane blended into grid until 2035 - Gas and in-fill buildings* take up H2 boilers and HHP - H2 blended in grid from 2030, piecewise conversion from 2035 - Solid biomass & bioliquid available off grid (elec. CF cannot switch to this) - No elec. resistive/storage on-grid	- Low amounts (all) biomethane blended into the grid - No uptake of gas-based technologies - Solid biomass & bioliquid available off grid (elec. CF cannot switch to this) - High T HPs offered only in this scenario - Hydrogen not available for uptake	- Biomethane blended into grid until 2035 - H2 not available for in-fill gas grid connections - On-gas move to H2 boiler, HHP or HP - Solid biomass & bioliquid available off grid (elec. CF cannot switch to this) - No elec. resistive/storage on-grid	- *Biomethane prioritised for industry* - Gas distribution grid decommissioned in 2040s - Solid biomass & bioliquid available off grid (elec. CF cannot switch to this) - No elec. resistive/storage on-grid - Hydrogen not available for uptake
Commercial / Public	*Same as above*	*Same as above* - Biomethane avail. off-grid post-2035	*Same as above*	*Same as above* - Biomethane avail. off-grid post-2035	*Same as above*
Industry	- No CCS/BECCS - 25 year tech. lifetime - ETS carbon price target of €150 by 2050	- High power BECCS, medium in Industry - High fossil CCS in power - Cost-effective hydrogen prioritised - All other choose most cost effective - Biomethane available off grid post-2035 - 15-year tech. lifetime (early retire) - ETS CO2 price target of €350 by 2050 used for uptake considerations**	- Limited power BECCS / industry - Limited fossil CCS - All suitable HPs are taken up if feasible and cost effective - Cost-effective electrification prioritised - All others choose most cost effective - No biomethane; allow biomass / H2 - 15-year tech. lifetime (early retire) - ETS CO2 price target of €350 by 2050 used for uptake considerations**	- Medium power BECCS / cement - CCS in core large industrial sites and some in power - Cost effective uptake; no enforced prioritisation - Biomethane available off grid post-2035 - 15-year tech. lifetime (early retire) - ETS CO2 price target of €350 by 2050 used for uptake considerations**	- Medium power BECCS, high in industry - High fossil CCS, limited in power - Cost-effective biomethane prioritised; when resource runs out, move to electrification. - On-gas can uptake biomethane and off-gas can take up biomass - 15-year tech. lifetime (early retire) - ETS CO2 price target of €350 by used for uptake considerations**
EE	Variation of policy across scenarios; external solid wall hidden costs excluded.				
DH	120 GWh by 2028	10% of heating demand in buildings (resi/com/pub)	30% of heating demand in buildings (resi/com/pub)	20% of heating demand in buildings (resi/com/pub)	30% of heating demand in buildings (resi/com/pub)
CF Bans	None	Public 2031, Residential 2032, Commercial 2034, Industry/Agriculture 2035			Public 2026, Residential 2027, Commercial 2029, Industry/Agriculture 2030
Grants	Available until 2027	- Available until the CF bans by sector - State aid limits for shallow energy efficiency packages (decreasing proportions for Medium and Deep) - State aid limits for low carbon techs., using 80% of an ASHP as the reference and applying the same monetary value against other techs for a given archetype			
Costs	Normal cost for radiator upgrades	Normal cost for radiator upgrades	Lowered cost for radiator upgrades	Lowered cost for radiator upgrades	Normal cost for radiator upgrades
Laggards	2030	2025			2021
Other	- 15 yr turnover for all CF tech. - Standard HP use (i.e. 29% off-peak)	- 15 yr turnover rate for all CF tech. - Flexibility/smartness of HPs (i.e. 9hr / 24hr off-peak/standard elec. price)			10 yr turnover for resi oil/gas boilers Flexibility/smartness of HPs (i.e. 9hr / 24hr off-peak/standard elec. price)

Glossary: resi = residential, com = commercial, pub = public, EE = energy efficiency, DH = district heating, CF = counterfactual, elec = electrical, tech = technology, HP = heat pump, HHP = hybrid heat pump.
*In-fill oil buildings account for 35% of the non-gas-based counterfactual stock.
** Increased CO2 price for ETS sites used solely for uptake calculations; CBA uses DPER prices rather than these increased prices.
Baseline uses the existing modelled policies (i.e. WEM, which end in 2027) and runs the NEMF in consumer mode from 2020 to 2050.

Key bottom-up policies considered

- A significant number of policies and policy targets are accounted for in the modelling. A selection of the key policies relevant for the heating sector is outlined in the below table:

Policy name	Description
Support Scheme for Renewable Heat (SSRH)	Offers ongoing operational support based on useable heat output for installations that use biomass or biogas boilers or CHP systems (covers new installations and converted installations). Aims to support an additional 1,600 GWh of renewable heat generation by 2025.
Excellence in Energy Efficiency Design (EXEED)	Provides grant support for major energy efficiency projects, of between 30% and 50% of total capex.
Better Energy Communities (BEC)	Provides grant support for energy efficiency projects, of between 30% and 35% of total capex.
Home Energy Grants	Provides fixed grants for residential homes for installing energy efficiency measures and low carbon heating systems.

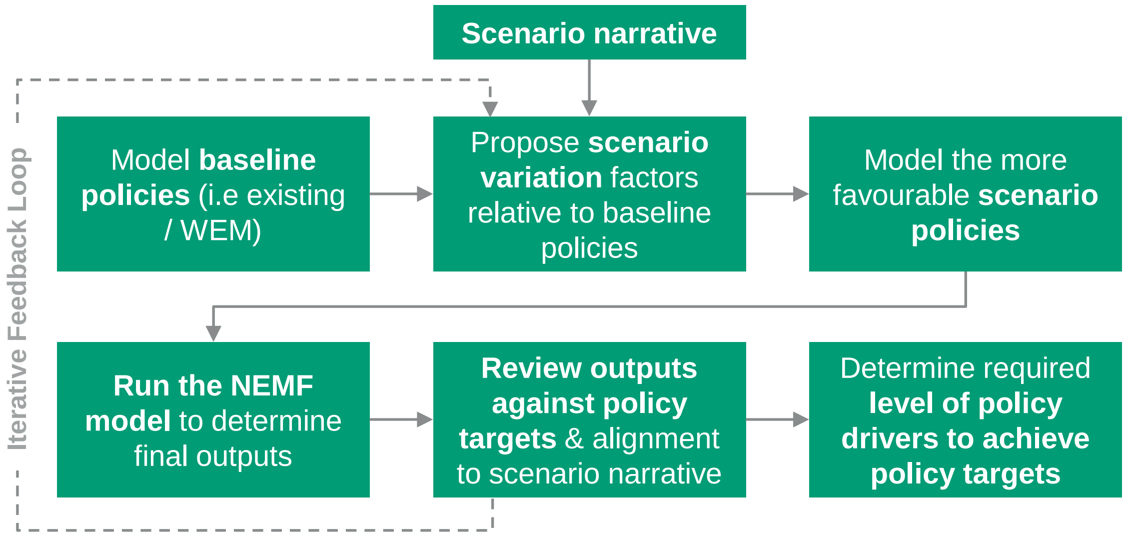
Key top-down policy targets considered

- A significant number of policies and policy targets are accounted for in the modelling. A selection of the key policy targets (largely based on the Climate Action Plan) relevant for the heating sector is outlined in the below table:

Policy target name	Description
RED II heat target	1.3 percentage points increase as an annual average for the periods 2021-2025 and 2026-2030, starting from the share of renewable energy in the heating and cooling sector in 2020, expressed in terms of national share of final energy consumption.
Electric Heat Pumps outside of SSRH	385K oil boilers, gas boilers, and electric heaters replaced by heat pump by 2030.
Biogas	1,600GWh of biogas use across the heat and transport sectors by 2030. Assumed linear increase from 2025.
Energy Efficiency Programmes	Retrofit 500,000 homes to a BER level of B2 or cost optimal equivalent or carbon equivalent by 2030. Retrofit all public sector buildings and 1/3 of commercial buildings to BER B by 2030.

Variation in bottom-up policy drivers between scenarios is set at an initial level; it will be varied in a process of model iteration

- For each of the four alternative scenarios, policy drivers are varied to match the scenario narrative.
  - For example, policies offering support for energy efficiency upgrades are boosted in scenarios where the narratives focus on increased levels of energy efficiency.
- The final level of policy variation will be determined through an iterative process, with the aim of determining the level of support required to achieve top-down policy targets.
  - This will form part of the iterative scenario modelling process in the following weeks.



Policy	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
SSRH	◕	◔	◑	◕
EXEED*	●	●	●	●
BEC	◔	◕	◑	◕
Home Energy Grants	◔	◕	◑	◕

Existing policy offers support up to permissible state aid limits

Fossil fuel phase-out dates

**date from which CFs are no longer available for uptake and when decision making switches from payback period to lifetime cost.*

Sector	Baseline	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Public	N/A	2031			2026
Residential		2032			2027
Commercial		2034			2029
Industry		2035			2030
Agriculture		2035			2030

Inclusion of consumer groups

**date from which the consumer group starts making decisions and is included into the choice modelling with the option of switching to a low carbon technology.*

Consumer group	Baseline	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Laggards	2030	2025	2025	2025	2021
Think all possible measures in place	2021				
Need more information					

Inclusion of H2 availability

2035 is the first year that H2 is available in Balanced and Decarbonised Gas. **2030** is the first year H2 is available in Rapid Progress.

Energy efficiency grants (absolute) - Baseline

Sector	Building Structure	Measure	Grant (€)	Years of Applicability
Residential	terraced house	cavity wall insulation	400	2020 – 2027
	semi-d house	cavity wall insulation	400	
	detached house	cavity wall insulation	400	
	apartment	cavity wall insulation	400	
	terraced house	solid wall insulation	2175	
	semi-d house	solid wall insulation	3350	
	detached house	solid wall insulation	4200	
	apartment	solid wall insulation	2175	
	terraced house	roof insulation	400	
	semi-d house	roof insulation	400	
	detached house	roof insulation	400	
	apartment	roof insulation	400	

Energy efficiency grants (percentage) - Baseline

Policy	Applicability					Exceptions
	End-state	Sector	Building Size	Grant ratio	Final energy consumption (kWh)	
EXEED	Deep	Industry	-	30%	>= 100,000	
EXEED	Deep	Commercial	Small	50%	>= 100,000	
EXEED	Deep	Commercial	Large	30%	>= 100,000	Matched by BEC equivalent (see below)
EXEED	Deep	Public	Small	30%	>= 100,000	Education not eligible; matched by BEC equivalent (see below)
EXEED	Deep	Public	Large	30%	>= 100,000	Matched by BEC equivalent (see below)
BEC	Medium	Residential	-	35%	-	These are not used as absolute grants are used as a separate input for Baseline (see previous slide).
BEC	Deep	Residential	-	35%	-	
BEC	Shallow	Commercial	-	30%	-	
BEC	Shallow	Public	Small	30%	-	50% for education
BEC	Shallow	Public	Large	30%	-	
BEC	Medium	Commercial	-	30%	-	
BEC	Medium	Public	Small	30%	-	50% for education
BEC	Medium	Public	Large	30%	-	
BEC	Deep	Commercial	-	30%	-	
BEC	Deep	Public	Small	30%	-	50% for education
BEC	Deep	Public	Large	30%	-	

N.B. All grants are modelled up to 2027 (aligned with NDP funding) for the Baseline scenario.

SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Energy efficiency grants (percentage) - scenario variation from Baseline

Sector	Baseline	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Variation (scalar applied) to increment grant funding	N/A	1.05	1.15	1.1	1.15
State aid limit applied – small commercial or public		50%			
State aid limit applied – large commercial or public		30%			

SSRH ongoing biomass support

- **Baseline:** support lasts for 15 years after end-date; i.e. ends in 2026, and so lasts from 2020-2040.
- **All other scenarios:** scheme lasts for additional 5 years; i.e. ends in 2031, and so lasts from 2020-2045.

Applicable technology	Applicable sector
Solid biomass boiler	Commercial, Public, Agriculture
Industrial Mixed Fuel Kiln + Calciner (high % biomass and waste fuel)	Industry
Industrial Biomass Boiler	Industry
Industrial Biomass CHP	Industry

N.B. All grants are modelled up to each scenario's sectoral fossil fuel phase-out date.

SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Heating system grants

Technology	Logic for column	Old grant (€, res) *Based on existing grants (applied in 2020 and for Baseline)*	Old grant (%, res) *Old grant, converted to a %, relative to the capex for a 5kW system*	New grant (%, res) *80% (max) for an ASHP; remaining technologies receive the same distribution as old grant % distribution (applied to non-Baseline scenarios)*	SSRH Grant (non-res) *30% (max) for an ASHP; remaining technologies receive the same distribution as relative capex of technologies (applied to non-Baseline scenarios)*
ASHP		3,500	50%	80%	30%
ASHP + solar PV HW		3,500	35%	56%	17%
ASHP + solar thermal		4,700	63%	80%	22%
Communal ASHP		3,500	100%	80%	30%
Electric resistive + HW HP		3,500	44%	70%	25%
GSHP		3,500	27%	43%	30%
High T ASHP		3,500	44%	70%	30%
High T GSHP		3,500	24%	39%	30%
Hybrid (ASHP + bioliquid boiler) - HW storage		3,500	37%	59%	23%
Hybrid (ASHP + gas boiler) - HW storage		3,500	41%	66%	25%
Hybrid (ASHP + hydrogen boiler) - HW storage		3,500	39%	62%	25%
Industrial Heat Pump - Medium Temperature (Hot Water)		N/A			30%
Industrial Heat Pump - High Temperature (Steam)					30%

N.B. All grants are modelled up to each scenario's sectoral fossil fuel phase-out date.

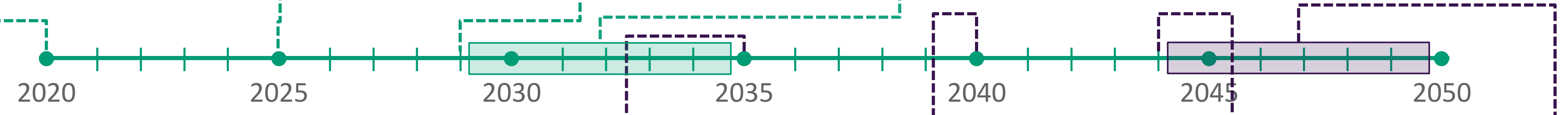
SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Decision Making Frequency & Stock Turnover Rate – Residential Gas & Oil Boilers – **Rapid Progress**

1. 1/10 of the stock has turned over their CF system
2. 6/10 of the stock has turned over their CF system
3. After 2029, the whole stock has replaced their original CF

During this period, no consumer HSs reach end of life; as such, there are no replacements or capex spent.

- The first set of replacements occurs based on the 10-year turnover set as an input.
- The whole stock is turned over by 2029.



- The second set of replacements occurs based on the 15-year lifetime of the heating system (i.e. the 10-year turnover that originally dictated the replacement rate no longer drives uptake; rather end of life for a consumer's HS does).
- The whole stock is turned over again by 2044.

1. The first 1/10 of stock who replaced their original CF in 2020, 15 years later *(based on the life time of the HS)*, now uptake again
2. By 2040, 6/10 of stock has replaced their heating system twice (once from the original CF and again now).
3. By 2044, the whole stock has replaced their heating system twice (once from the original CF and again now).

During this period, no consumer HS reach end of life; as such, there are no replacements or capex spent.

- In Rapid Progress, because the 10-year turnover rate is not aligned to the lifetime of heating system being replaced (i.e. 15 years), we do not see an even yearly capex expenditure by consumers; we see drops in capex during the period after the whole stock turns over (i.e. after 10 years), but before the lifetime of the HSs purchased by the first 1/10th of consumers ends (i.e. after 15 years).
- The residential CF ban date is in 2032, but as seen from the above, does not affect the replacement rate as CF and RT systems all have a 15-year lifetime; the model outputs however may see increased [€/HS] from 2032 onwards.

SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Decision Making Frequency & Stock Turnover Rate – Residential Gas & Oil Boilers – **Other Scenarios**

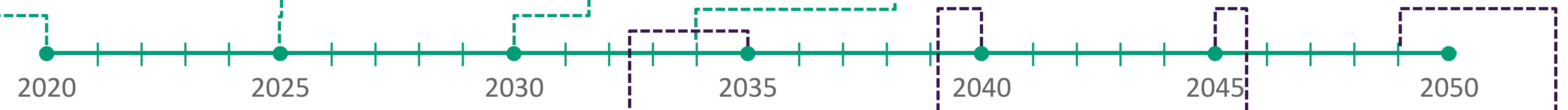
1 — 1/15 of the stock has turned over their CF system

2 — 6/15 of the stock has turned over their CF system

3 — 11/15 of the stock has turned over their CF system

4 — After 2034, the whole stock has replaced their original CF

- The first set of replacements occurs based on the 15-year turnover set as an input.
- The whole stock is turned over by 2034.



- The second set of replacements occurs based on the 15-year lifetime of the heating system (i.e. the 15-year turnover that originally dictated the replacement rate no longer drives uptake; rather end of life for a consumer's HS does).
- The whole stock is turned over again by 2049.

1 — The first 1/15 of stock who replaced their original CF in 2020, 15 years later *(based on the life time of the HS)*, now uptake again

2 — By 2040, 6/15 of stock has replaced their heating system twice (once from the original CF and again now).

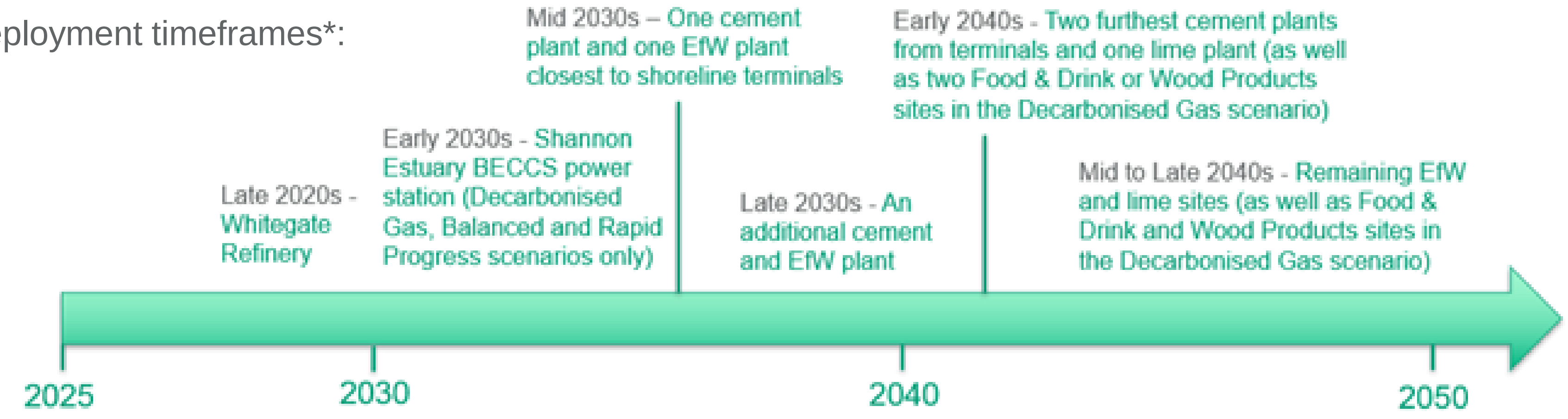
3 — By 2045, 11/15 of stock has replaced their heating system twice (once from the original CF and again now).

3 — By 2049, the whole stock has replaced their heating system twice (once from the original CF and again now).

- In these scenarios, because the 15-year turnover rate is aligned to the lifetime of heating system being replaced, we see an evenly spread-out output of capex over time (i.e. 1/15 of the stock is always purchasing a new HS in any given year).
- The residential CF ban date is in 2027, but as seen from the above, does not affect the replacement rate as CF and RT systems all have a 15-year lifetime; the model outputs however may see increased [€/HS] from 2027 onwards.

CCS/BECCS illustrative timeline

Indicative deployment timeframes*:



CCS/BECCS capex spend timeline by counterfactual fuel

Counterfactual Fuel	Baseline	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Non-bio waste	N/A	2035 – 2042	2030 – 2042	2030 – 2042	2030 – 2042
Bio waste		2035 – 2042	2030 – 2042	2030 – 2042	2030 – 2042
Bio fuel		2042 – 2048	2030 – 2042	2035 – 2042	2030 – 2042
Gas		2028 – 2048	2028	2028 – 2048	2028 – 2048
Oil		2028 – 2048	2028	2028 – 2048	2028 – 2048
Solid fuels		2035 – 2048	-	2030 – 2048	2042 – 2048

*This timeline is illustrative and reflects only one possibility of deploying CCUS in the coming decades

SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Scenario narrative – overview

Category	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Power	High uptake of gas CCS and BECCs, with the latter's fuel stock mainly supplied by imported solid biomass. Lower requirement for green hydrogen deployment and RES-E shares.	High uptake of green hydrogen required to decarbonise conventional generation. High electricity demand requires highest roll-out of variable renewable generation to reach target RES-E shares.	Mix of technologies. Medium growth of CCS, BECCs, and green hydrogen.	Accelerated deployment of variable renewables. Earliest deployment of hydrogen (2030, in comparison to 2035 for other scenarios with hydrogen). CCS and BECCs play a role.
Heat	The gas network is decarbonised using green hydrogen, with electricity supplied via wind farms co-located with electrolysers. Off-gas homes are decarbonised via electricity (heat pumps) or containerised biomethane.	Heat pumps are the primary route to heat decarbonisation in buildings in all areas. Hard-to-decarbonise homes in rural areas rely on solid biomass boilers. The gas network is largely decommissioned, but remains in urban areas to deliver biomethane to hard-to-decarbonise buildings. There is high deployment of DH in heat-dense areas.	Mix of technologies. The gas grid is decarbonised using green hydrogen, with electricity supplied via wind farms co-located with electrolysers. Off-gas buildings are decarbonised via electricity (heat pumps), solid biomass, and containerised biomethane.	Buildings are primarily decarbonised via electrification and the gas distribution grid is decommissioned. There is high deployment of DH in heat-dense areas.
Industry	Industrial heat is slanted towards a mix of green hydrogen, fossil CCS, and BECCS, which is supplied by a mix of domestic and imported biomass. Electrification plays a relatively limited role.	High reliance on electricity for decarbonisation, with limited use of low carbon gases. Relatively limited use of bioresource and very limited CCS.	Mix of technologies.	Rapid uptake of biomethane, prioritised for industry and a relatively balanced mix of other low carbon technologies. There is early deployment of CCS in industry, relying on a mix of bio feedstocks. Hydrogen is available for industry from 2030. By 2050, hydrogen and biomethane are delivered to industry through parallel transmission networks.
Bioresource	There is strong support for AD (both crops and system deployment). The resulting biomethane is containerised and used to replace oil in off-gas buildings.	Strong support for perennial energy crops used to produce solid biomass. This is used in industry and in rural hard-to-decarbonise buildings.	Mix of crops for AD and perennial energy crops for solid biomass	Reductions in the national beef herd lead to more land being available to grow crops for AD. The resulting biomethane is supplied to the grid for use in industry. Some biomethane may also be containerised for the grid for use in industry. Some biomethane may also be containerised for the off-gas grid stock.

Scenario narrative – buildings

Category	Baseline	Common to all alternative scenarios	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Building heating technologies	- Existing policy measures only - Most remain fossil boilers or direct electric heating	- New dwellings to be NZEB from 1 Nov. 2019 - New buildings* to be NZEB from 1 Jan. 2019 *Targets used to guide analysis (not assumed to be achieved – uptake defined by policy simulation)* *- At least 385K HPs by 2030* *- 1,600GWh of renewable heat to 2025* *- REDII heat target achieved.*	- Buildings on gas grid use boilers or hybrid heat pumps (hydrogen). Buildings near to the grid are connected as 'in-fill.' Containerised biomethane is available for off-gas hard-to-decarbonise buildings	- Predominantly heat pumps supported by direct electric technologies - Hard-to-decarbonise buildings use biomass and biomethane in rural and urban areas, respectively	- Mix of technologies	- Accelerated, notably to 2030 - Mix of technologies, with gas distribution grid earmarked for decommissioning by 2050.
Energy Efficiency	- Existing policy measures only	*CAP targets (guide - not assumed to be achieved):* *- 500,000 homes to BER B2 by 2030* *- All public buildings to BER B by 2030* *- 1/3 of commercial buildings to BER B by 2030*	- More favourable policy measures aiming to meet CAP BER targets	- Highly favourable policy measures aiming to meet CAP BER targets and surpass these where required or where cost-effective	- More favourable policy measures aiming to meet CAP BER targets	- Highly favourable policy measures aiming to surpass CAP BER targets
Heat networks	-Limited deployment	N/A	- Relatively low deployment	- Relatively high deployment	- Medium deployment	- Relatively high deployment

* Excluding dwellings

Scenario narrative – gas grid and low carbon gases

Category	Baseline	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Gas grid extent	- Current gas grid maintained, ~ 700,000 connections	- Expansion of gas grid for domestic/commercial connections - Increased use of gas in industry	- Gas distribution network curtailed in some areas due to reduced demand - Significant reduction in demand from industry	- Gas grid maintained although demand is reduced. - Reduced use of gas in industry	- Gas distribution grid is decommissioned in the 2040s
Gas grid composition	- No H2 - Existing production, injection and use of biomethane	- Green hydrogen	- Biomethane in remaining areas of gas grid - H2 production only for electricity grid services	- Green hydrogen	- 1,600GWh of biogas use across the heat and transport sectors by 2030 - By 2050 biomethane and hydrogen are delivered through parallel transmission networks

Scenario narrative – industry & power

Category	Baseline	Common to all alternative scenarios	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Industrial Heat	- Slow progress, industrial applications remain fossil, some efficiency.	Some sites choose the same options in all scenarios as options are highly favoured.	- High share of industrial processes using low carbon gas - Lower efficiency improvements	- Low T applications nearly all electrified. - Some H2/CCS for High T applications. - High efficiency improvements.	- Low T applications mostly electric - Biomethane and/or H2 at core sites (high-temp, non-CCS) - Medium efficiency improvements.	- Low T applications nearly all electrified (low cost electricity). - Biomethane prioritised for transmission-connected industry. - Hydrogen becomes available for industry from 2030. - High efficiency improvements.
BECCS	None	N/A	- High BECCS in power - Medium-high BECCS in industry - ~9 MtCO2 -ve emissions in 2050	- Limited BECCS in power - Limited/no BECCS in industry - ~1 MtCO2 -ve emissions in 2050	- Medium BECCS in power - Medium BECCS in Industry - ~5 MtCO2 -ve emissions in 2050	- Medium BECCS in power - High industry BECCS - ~6 MtCO2 -ve emissions in 2050
Fossil CCS	None	N/A	- Highest level of Industrial CCS - High CCS in power	- Later & limited scale industrial CCS - No CCS in Power	- Core large industrial sites - Medium Power CCS	- Medium Industrial CCS, earlier - Limited CCS in Power

Scenario narrative – bioenergy

Category	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Theme	Maximise AD resources	Maximise perennial energy crops	Mix of AD and perennial energy crops	Additional AD resources
Silage for AD	Silage grown on land released due to decline in national beef herd and improvements in productivity	No additional silage grown for AD	Half of land released used to grow silage for AD and half used to grow perennial energy crops	As decarbonized gas scenario, but additional land released, as national beef herd declines by more than in current projections
Perennial energy crops (SRC willow)	No expansion	Perennial energy crops grown on land released due to decline in national beef herd and improvements in productivity um possible		
Afforestation	Afforestation target of 8,000 ha/yr met every year to 2050			

Scenario narrative – power system considerations

Category	Baseline	Common to all alternative scenarios	Decarbonised Gas	High Electrification	Balanced	Rapid Progress
Green H2 demand	None	N/A	Low	High	Medium	Medium
CCS	None	N/A	High	None	Medium	Low
BECCS*	None	N/A	High	Low	Medium	Medium
Fuel and carbon prices	Consistent set of assumptions for (i) fuel prices, taken from the Low trajectory of the BEIS2019 fossil fuel price assumption, and (ii) ETS prices, taken from EU Reference scenario.					
Non-heat electricity demand	Consistent transport electrification (majority of passenger and LGV) and data centre (median) growth assumptions across all scenarios.					
Heat electricity demand		Dynamically modelled on an annual basis based on varied annual heat electrification uptake.				
RES-E share	2025: <45% 2030: ~60% 2040: ~70%	2025 : ~55% 2030 : >=70% 2040 : ~80%				

** The BECCS/CCS scenarios represent a range of possibilities for BECCS/CCS deployment*