18 FOR 0

EirGrid SUBMISSION

TES 2023

About 18for0

18for0 is a voluntary group of professionals concerned about the credibility of current proposals to achieve net zero emissions in Ireland by 2050.

Ireland must implement a wider range of options than is outlined in the current Climate Action Plan in order to achieve the required carbon emissions reductions in an affordable and environmentally responsible manner that also retains stability and security in the electricity grid. We aim to present the environmental and economic case for modern nuclear energy to a wider Irish audience and to outline Ireland's capability to operate a robust nuclear power programme.

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Introduction

The Tomorrow's Energy Scenarios 2023 (TES 2023) is a high quality study of 3 scenarios that model a net zero power system from 2040, and a Constrained Growth scenario that models net zero power from 2050.

Developing a net zero power system is an extraordinary challenge that is summarised by TES 2023: "*Similarities have been drawn between this challenge and that of electrifying rural Ireland and Northern Ireland, however,* ***the scale of change necessary is unprecedented*** *in today's world. Cooperation and collaboration will be a fundamental aspect of this change*".

We welcome the opportunity to make this submission, some of which runs counter to much of the public discourse to date on this topic, but which our work shows could be essential to adequately address both the scale of change necessary and the risks and uncertainties surrounding technologies and infrastructure that are currently being considered.

Specifically, we propose including a Balanced Inclusive scenario that does not exclude any low emissions technologies that could be appropriate for Ireland. The Balanced Inclusive scenario includes a suitable amount of nuclear energy, CCS, Hydrogen and Renewables, and allows all low emissions technologies to perform to their optimum extent in providing Ireland with a net zero power system as soon as possible and with least risk and lowest projected cost to the customer.

We earnestly request that our proposal Balanced Inclusive for Zero emissions (BIZ) scenario is given full consideration and is included in the final version of TES 2023 to ensure that policy decisions in this critical area are based on the best available information.

This submission

There are 5 primary points being made in this submission.

1. The significant risks identified in TES 2023 make achievement of a net zero power system a far-from-certain outcome. Given the importance of the outcome, TES 2023 should consider the full range of options available to it
2. TES 2023 appears to have an unjustified limitation on the sustainable technologies considered, especially relating to the particular exclusion of Nuclear energy
3. We suggest a balanced Inclusive alternative scenario where nuclear is included to help develop a net zero power generation portfolio faster and with less risk
4. The Consultation does not provide enough information to allow fully informed submissions to be made regarding power generation portfolios and their resultant system emissions, and
5. The Constrained Growth scenario appears to carry excessive risk.

We make this submission based on information contained in TES 2023 and other official sources in the interests of trying to have all viable technologies assessed for their potential to assure Ireland of clean and affordable energy as soon as practicable and at least risk.

Glossary of Terms

BECCS	Biomass with Carbon Capture and Storage
BIZ	Balanced Inclusive scenario for Zero emissions
CCGT	Combined Cycle Gas Turbine
CCS	Carbon Capture and Storage
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
Mt	Million tons
MW	MegaWatt
OCGT	Open Cycle Gas Turbine
PV	Solar Photovoltaic
TWh	TeraWatt hour

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1 - Risks

TES 2023 identifies many significant risks facing all net zero power system scenarios, where words in italics are direct quotations from TES 2023:

- **Flexibility:** TES 2023 states that *Demand will need to follow renewable output to a greater extent than at present* and anticipates requiring *20–50% demand flexibility*. There is a very significant risk that users will not be willing or able to provide this flexibility or that industry demand side units will not begin to be powered by genuine zero emissions sources.
- **Transmission:** *Very significant development of network capacity and zero carbon system services* could require an *unprecedented upgrade to the transmission system*. This is also a significant risk, as there has been no evidence to date that Ireland will deliver this development.
- **Capacity:** Decarbonising electricity will require: *large and rapid rollout of renewable generation capacity* (particularly offshore wind and solar PV); *significant growth of energy storage capacity***,** including batteries of various durations; a*cceleration of green fuels (hydrogen, biomass and biomethane)* to offer reliability and flexibility to the power system; *Negative emissions technologies to capture and store carbon* and balance emissions from conventional capacity; and *significant increases in electricity interconnection* to enable energy imports and exports.

TES 2023 also acknowledges that it only considers Dispatch Down of renewable generation and does not consider Constraints and Curtailments that still have a significant impact on renewable output.

Because achieving a net zero power system will be jeopardised to the extent that any of the above risks are realised, it is critical that all viable clean energy sources are considered.

2 - Limitation

TES 2023 outlines that a key enabler of achieving net zero power is a balanced portfolio of generation technologies, with renewables supported by energy storage, interconnection and firm dispatchable capacity, such as hydrogen, bioenergy and CCUS (Carbon Capture, Usage and Storage).

However, TES 2023 has not considered all sources of firm dispatchable capacity that can be viable in Ireland. In particular, TES 2023 has omitted nuclear energy although the EU recognises nuclear as a sustainable and strategic clean energy technology and it is a viable energy source for Ireland.

The last EirGrid study that considered nuclear energy in a low carbon electricity study[1] found that no scenario resulted in lower emissions or lower costs than the scenario that included nuclear energy.

Both SEAI and ESB recently reported that Ireland should consider small modular nuclear reactors (SMRs) when they become available. The critical parameters of existing small reactors and Western SMRs that are nearing commerciality - including maximum and minimum load, ramp rates, and inertia - are sufficiently well known to include them in net zero power system models. There is no technical reason to omit nuclear energy from models of net zero power systems in Ireland.

Although commercial cost data is not yet available for Western SMRs, it is available for existing small reactors. This is similar in many ways to offshore wind turbines, hydrogen and BECCS/CCS power

[1] http://bene.ie/wp-content/uploads/2018/04/POYRY-2010-Low-Carbon-Generation-Options-for-the-All-Island-Market.pdf

generators that are included in TES 2023 but where commercial cost data is not yet available. In any case, "*Cost assessment is not included the scope of TES 2023 2023 and our analysis of the scenarios*", which implies that a lack of cost data is not a valid reason to exclude nuclear energy from TES 2023.

Some say that nuclear energy shouldn't be considered because electricity generation by nuclear fission in Ireland is not permitted here. However, TES 2023 considers CCS and BECCS to be essential in a net zero power system by 2040 or 2050, even though Carbon Storage is not currently permitted in Ireland[2] either. So, current legislation is not sufficient grounds to exclude Nuclear energy.

But should nuclear energy be excluded because nuclear fission power generation in Ireland is not part of current government policy? Leaving aside the prejudicial situation where Government policy favours nuclear electricity only if it is generated abroad, Government must have factual information concerning difficult matters so they can assess whether policy should be revised or maintained.

There are some parallels here to long-held policy positions regarding Divorce, Same-Sex Marriage and Abortion, for example, that had been widely assumed to be immutable and yet were recently reversed with political support following detailed assessment of the underlying arguments.

It is important that TES 2023 provides robust analysis of all plausible power system scenarios, so that government policies can be best on solid information, rather than simply follow the status quo. It follows that Nuclear energy should be considered in TES 2023, perhaps in a "**Balanced Inclusive**" scenario that includes all the viable technologies listed below.

- Nuclear
- Wind – offshore and onshore
- Solar PV
- Biomass with CCS (BECCS)
- Gas CCGT and OCGT without CCS
- Gas CCGT and OCGT with CCS
- Interconnection
- Storage
- Hydro
- Ocean
- Renewable Waste
- Combined Heat & Power
- Hydrogen, and
- Demand Side Units

This scenario could also model using nuclear energy to produce Hydrogen. There is ample international research showing that matching electrolyser capacity with nuclear energy capacity can deliver a constant supply of Hydrogen more effectively and more economically than by using Offshore Wind exclusively, for example.

[2] "4. (1) The storage of CO2 in a storage site in part or in the whole of the area referred to in Regulation 3(2) is not permitted" " https://www.irishstatutebook.ie/eli/2011/si/575/

3 – Our proposed Balanced Inclusive scenario

We developed a Balanced Inclusive scenario for Zero emissions (BIZ) based on the TES 2023 Constrained Growth scenario. BIZ assumes that Ireland removes the existing legislative and political barriers it has chosen to erect and which mitigate against developing the most practical and cost effective net zero power system.

Specifically, BIZ assumes that the legislation inhibiting both CCS and Irish Nuclear Fission power generation is rescinded, and that the standard political ideology adapts to promote policies that target a sustainable and reliable net zero power system in the shortest timeframe and at least cost.

The characteristics of the Balanced Inclusive scenario for net zero in 2050 are outlined in Table 1.

Table 1 Characteristics of the Balanced Inclusive (BIZ) scenario in 2050

Technology	MW installed	Capacity factor, %	Energy, TWh	Emissions Intensity, kg/MWh	Emissions, Mtons
Wind - Onshore	11,100	37%	29.3	0	0
Wind - Offshore	5,700	50%	20.4	0	0
Solar PV	9,100	11%	7.1	0	0
Gas CCGT	75	0%	0	500	0
Peak	2,603	0%	0	700	0
Hydro	220	35%	0.7	0	0
Biomass with CCS (BECCS)	75	85%	0.6	-900	-0.5
Renewable Waste	100	55%	0.4	400	0.15
Ocean	100	26%	0.2	0	0
Nuclear	3,000	88%	23.1	0	0
Conventional CHP	180	22%	0.3	400	0.14
Demand Side Units	1,250	5%	0.5	0	0
Gas with CCS	900	65%	5.1	50	0.26
Hydrogen	0	0%	0	0	0
Storage charging			-8.4	0	0
Storage generating			7.0	0	0
Renewables Dispatch Down		18.8%			
Interconnection Export	3,850	12%	-4.0	0	0
Interconnection Import	3,850	45%	15.2	0	0
Totals			95.1		0.0

BIZ assumes that all power generation plant is installed as detailed in TES 2023 Constrained Growth scenario for the period up to 2035. Thereafter, Nuclear energy capacity is introduced from 2036 at the rate of 300 MW per year until 2,400 MW of Nuclear capacity is installed by 2043, and 3,000 MW is installed by 2049.

Because Nuclear energy provides firm capacity, it directly replaces Gas Turbine CCGT and OCGT capacity, which can then not be replaced at its end of life. This is unlike the other 4 TES 2023 scenarios that require CCGT and OCGT capacity to be retained at 2030 levels until 2050 to ensure that Peak Demand can be met at all times.

As Nuclear energy is also the lowest emitter of greenhouse gases on a full lifecycle basis, it tends to run at the highest capacity factor it can, as happens with other low emissions technologies. This low emissions Nuclear power generation can then also directly avoid the need for a large quantity of the Gas with CCS capacity that is projected in the Constrained Growth scenario, thus minimising the large investment needed for Gas with CCS.

Some Nuclear capacity can also be used to hedge against situations where low emissions capacity, including Hydrogen, can't be built or replaced for economic or technical reasons, or even if they are no longer wanted in the areas in which they were originally located.

As Nuclear energy also provides system services, including Inertia, Operating Reserve and Reactive Power, there will be a reduced need for such capacity compared to the Constrained Growth scenario.

Regarding emissions, which is the primary purpose of the study, the Constrained Growth scenario appears to result in emissions of around 7.4 M tons in 2040 and over 27 M tons in the 2040's, before delivering net zero emissions power in 2050.

On the other hand, the Balanced Inclusive scenario could result in emissions of around 1.7 M tons in 2040 and less than 6 M tons in the 2040's, before delivering net zero emissions power by 2045.

4 - Consultation information

Our approach in developing this submission was to develop one of the 4 scenarios in TES 2023 so that its fossil fuel component was replaced as quickly as possible with an appropriate amount of nuclear energy in a Balanced Inclusive scenario. We had used this approach to good effect in assessing Ireland's clean energy options as projected in the Climate Action Plan 2019, for example.

However, as the TES 2023 Consultation did not provide enough information to allow us to replicate the results of any scenario, our efforts to develop an additional scenario were somewhat frustrated.

In order to make an informed submission regarding alternative power generation portfolios, it would have been useful to have had access to the capacity factors (or annual energy output) and the assumed emissions intensity of different categories of plant for the years in question (2035, 2040, 2045 and 2050).

5 - Constrained Growth scenario

Given the limited time available to us to conduct our research; our difficulty in replicating the TES 2023 results due to the lack of underlying data; and that we don't have access to the sophisticated tools used to develop the scenarios, we could only base our work on a single TES 2023 scenario. We selected the Constrained Growth scenario as we considered that to be the most likely scenario.

Despite the best efforts of Government who are working very hard to deliver the Climate Action Plan 2023, Irish energy experts routinely reflects the opinion that Ireland will not meet its 2030 offshore wind energy targets for a variety of reasons related to costs, auctions, planning and permitting. For example, it is not unusual to hear opinions that there will be no more than 2,000 MW of Offshore Wind capacity commissioned in Ireland by 2030, which is only just over 6 years away.

Timely development of 5,000 MW of Offshore Wind is critical to all TES 2023 scenarios apart from the Constrained Growth scenario. As the Constrained Growth scenario is the only one to reflect the prediction that Ireland will have only 2,000 MW of Offshore Wind installed by 2030, the Constrained Growth scenario appeared to be the most likely of all, so it was the one we tried to replicate.

The Constrained Growth scenario is described as achieving net zero emissions from 2050, by which time customer demand is projected to be 95 TWh. To supply this demand, our model assumes very optimistic reliability and emissions intensity data for all power generation capacity, and assumes that all renewable generators operate at their maximum reasonable rating.

To model the Constrained Growth scenario such that it delivers net zero in 2050, we assume a power generation portfolio with characteristics as outlined in Table 2**Error! Reference source not found.**.

Table 2 Characteristics of the Constrained Growth scenario in 2050

Technology	MW installed	Capacity factor, %	Energy, TWh	Emissions Intensity, kg/MWh	Emissions, Mtons
Wind - Onshore	12,000	37%	31.8	0	0
Wind - Offshore	9,800	52%	36.0	0	0
Solar PV	13,400	11%	10.5	0	0
Gas CCGT	1,575	0%	0	500	0
Peak	4,175	0%	0	700	0
Hydro	220	35%	0.7	0	0
Biomass with CCS (BECCS)	75	85%	0.6	-900	-0.5
Renewable Waste	100	55%	0.5	400	0.19
Ocean	100	26%	0.2	0	0
Conventional CHP	180	7%	0.1	400	0.04
Demand Side Units	1,250	5%	0.5	600	
Gas with CCS	2,250	26%	5.1	50	0.26
Hydrogen	0	10%	0	0	0
Storage charging			-8.4	0	0
Storage generating			7.0	0	0
Renewables Dispatch Down		18.8%			
Interconnection Export	3,850	-14%	-4.7	0	0

Interconnection Import	3,850	45%	15.2	0	0
Totals			95.0		0.00

A very optimistic CO_2 capture rate of 900 kg/MWh would see Biomass with CCS (BECCS) capture a total of 0.5 Mt per year and fully offset emissions from Renewable Waste, Gas with CCS and a small amount of Conventional CHP, and still yield net zero emissions power generation.

Note that Gas with CCS and Conventional CHP both still result in emissions and so can only have low capacity factors in order to keep total emissions zero. This will result in a very high cost of electricity from these generators that could well set the marginal price for electricity, if that is how the market operates in 2050.

Even these optimistic assumptions leave a shortfall in power generation in Ireland of around 10.5 TWh per year, or around 11% of our electricity in 2050.

Although there is almost 23,000 MW of Wind and 13,400 MW of Solar PV installed, along with other 'must-run' plant including BECCS, Renewable Waste and Gas with CCS, if annual exports exceed 4.7 TWh, imports will require over 45% capacity factor on the interconnector, which we believe would be excessive.

It could also be unwise to depend on such a large portion of our electricity to be imported, especially if imported clean energy in 2050 proves not to be as affordable or as available as is hoped.

However, our analysis using the limited data and tools available to us suggests that this scenario may be unrealistic or even unachievable, where 2045 and 2050 are concerned. We are, of course, open to correction on our findings.

These results of our model of the Constrained Growth scenario indicate an excessive risk associated with this scenario, even though it relies on very optimistic assumptions of capacity factor and emissions intensity and depends on none of the risks alluded to in Section 1 Risks becoming realised.

6 - Comparison with the balanced Inclusive scenario

We compare the Constrained Growth with the Balanced Inclusive (BIZ) scenario in Table 3**Error! Reference source not found.**.

Table 3 Comparison of Constrained Growth and Balanced Inclusive scenarios

Parameter	Units	Constrained Growth	Balanced Inclusive
Emissions in 2040	Million tons	7.4	1.7
Emissions from 2041 to 2050	Million tons	27.6	5.5
Emissions in 2050	Million tons	0	0
Total capacity installed in 2050	MW	50745	42451
Energy supplied in 2050	TWh	95.0	95.1
Surplus plant at 2050 Demand Peak	MW	2886	1109
Interconnector exports in 2050	%	14%	14%
Interconnector imports in 2050	%	45%	40%

This shows that the BIZ scenario can result in lower emissions sooner than the Constrained Growth scenario; requires less power generation infrastructure; and provides useful tools to mitigate the genuine and serious risk inherent in any plan to achieve a net zero power system.

Note: We found no credible power generation capacity factors that could model projected 2040 generation using the Constrained Growth power generation capacity while keeping emissions as low as the 1.7 Mt that is projected by TES 2023 for that scenario. We would welcome further information to help us resolve this finding, which may be due to an undetected error on our part.

We have summarised our findings regarding emissions per decade in Figure 1.

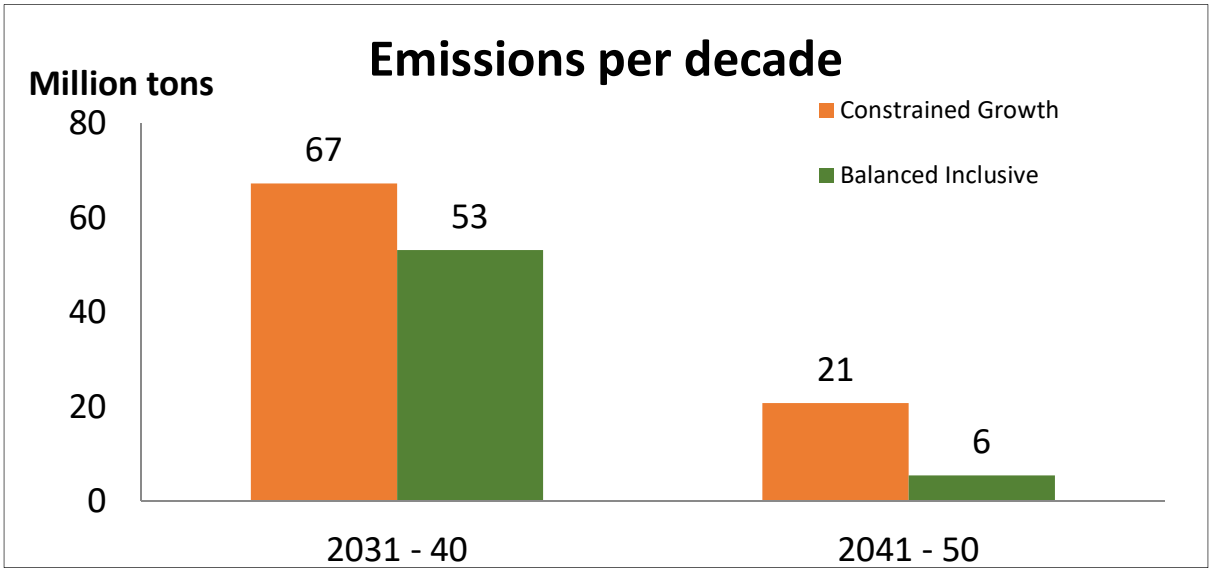

Figure 1 Comparison of emissions per decade between Constrained Growth and Balanced Growth scenarios

Figure 1 demonstrates the significant reduction in emissions that are possible when Nuclear energy replaces Gas CCGT and Gas OCGT as well as CHP and Gas with CCS in the Constrained Growth scenario.

Conclusion

We believe that there is a strong case for developing a scenario in TES 2023 that objectively considers an appropriate amount of nuclear energy along with other low emissions technologies.

We also believe that there is no strong reason for excluding nuclear energy from all TES 2023 scenarios.

We earnestly request that our proposal Balanced Inclusive for Zero emissions (BIZ) scenario is given full consideration and it, or some reasonably equivalent scenario, is included in the final version of TES 2023 to ensure that policy decisions in this critical area can be based on the best available technical information.

Appendix

1. Please note a point that could be clarified TES 2023. Page 66 of TES 2023 says "*Curtailment is applied to all renewable generators across the island on a pro-rata basis. (see graph of percentage curtailment annually by scenario in Figure 6.5 below)*". This appears to contradict another statement on page 66, "*The reduction of available renewable generation for oversupply reasons is necessary when the total available generation exceeds system demand plus interconnector export flows. Of these three forms of dispatch-down, only surplus renewable generation is considered in our model, as network and operational constraints are not considered. Therefore, the level of dispatch-down shown below could be higher in reality if network and operational constraints were also considered*".

Can you please clarify whether curtailment and constraints are modelled in TES 2023 or do you simply model Dispatch Down, as appears to be the case?

2. General note: It is standard practice in calculating power system emissions to allocate '0 Emissions' status to renewable technologies including Offshore and Onshore Wind, Solar PV, Hydro, Biomass and to energy storage technologies including Pumped Hydro, Battery and Hydrogen, as all apart from Hydrogen emit negligible emissions to air during operation. In the real world, there are real and quantifiable emissions associated with construction and operation. The result is that a power system may be net zero in name only but not in practice.

3. We accept that there may be errors, omissions and misunderstandings contained in our submission, which we submit in good faith. We will be happy to correct these where they are made known to us.

4. We can provide further information of a technical nature or otherwise upon request, to assist you in understanding our submission or in further developing the proposed Balanced Inclusive scenario.