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Engineering for net zero emissions

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The IES Energy Strategy Group was formed in 2008 to promote the principle that planning for the energy system in general and for the electricity system in particular needs to be based on sound engineering principles.

Abstract

The success of efforts to achieve the UK goal of net zero emissions by 2050 will be critically dependent on the actions taken by government. We explain why government decisions for achieving the goal must be based on proposals that have been 'engineered' by a specially appointed body.

How to 'engineer' a proposal

As an insight into how engineered proposals are formulated, consider this 2006 statement about the design of a £120 million water treatment works (Allen and Watts 2006).

> "Over 100 technical staff from 25 different disciplines considered 6000 possible options and 17 potential development areas were looked at in great detail. In total some 196 potential schemes were evaluated with respect to environmental impact, cost and risk. The development processes drew on the expertise of the various partners and set the project governance and decision-making methodology. Value and Risk Management practice underpinned the process."

Core principles for an engineered approach are encapsulated in that statement, i.e.: take account of all issues; address the complexity; look widely for expert support (25 disciplines!); start by considering a wide range of possibilities – all options are 'on the table'; test the options against the requirements in great detail using a range of assessment methods; identify unintended consequences; narrow the choice and makes decisions on the basis of informed judgement.

We use here the word 'engineered' as relating to the skilful solution of problems in situations of complex uncertainty (Macleod 2017).

The role of professional engineers in society

The Government is making decisions about energy, will make decisions about energy and has to make such decisions if the goal is to be achieved.

If you have a pain in your chest you would not ask your lawyer for advice, you would consult with a medical doctor. If you have a complex technical problem that involves a wide range of issues requiring input from several disciplines, then the relevant profession is engineering. It is not only engineers. In order to address the net zero goal a multidisciplinary team of people – engineers, scientists, economists, environment specialists, psychologists, etc. – needs to be trusted with the responsibility of engineering the actions that government will take (IES 2018).

Achieving net zero

In order to achieve the net zero goal, parts of the energy system (such as for transport, heating and electricity supply) need to be subject to major transformations. They have to be redesigned, re-engineered.

Challenges of the net zero target include:

- Urgent action is needed but it is difficult to get people to accept the necessity for action
- It is very large, highly complex task: there are conflicting requirements and many interdependencies among the components of the energy system

- Many of the issues are of a specialist technical nature (e.g. the engineering of the electricity system)
- There are major social and economic issues.
- There are high levels of risk e.g. in relation to decline in the reliability of supply of energy (whether hydrogen, electricity or some sustainable alternative), potential for cost escalation, etc.
- Significant innovation is needed; innovation adds to the level of risk

The present decision-making process for energy issues is that government ministers are responsible for formulating proposals. They take advice from a range of sources but have the power to make decisions based on their own preferences rather on the results of detailed studies of the efficacy of proposals. Doing that, breaks a golden rule in engineered decision-making that before a proposal is accepted, it has to be challenged and tested. Not doing that makes the outcomes wide open to failure.

A National Energy Authority

In order to achieve engineered decision making, we advise that a National Energy Authority (NEA) be assigned responsibility for formulating proposals for energy for transport, electricity, heating etc. and for ensuring that the decisions are properly implemented. This would not remove responsibility from Government in these matters but would ensure that the risk of taking inappropriate action would be controlled. Proposals from the Authority could be approved, required to be reconsidered or rejected by ministers but, for the reason stated above, ministers would not change a proposal unless the alternative strategy had been tested and shown to be likely to produce improved outcomes. Ministers would work closely with the Authority to seek to satisfy the requirements.

The Authority would synthesise the work of government bodies, consultants, researchers, energy suppliers, etc. The reasoning behind proposals would be made available to the public who would be invited to make contributions about them before decisions were made. The intellectual capital of the nation would be harnessed to the achievement of the net zero goal. The NEA would collaborate with similar organisations around the world to share projects and experiences.

Our discussion here does not address the details of how a NEA concept would be integrated into the present government arrangements for energy policy.

Could it work?

While infrastructure is just one of the issues in energy production and use, how infrastructure is procured by government has close parallels with what we propose. It is normal for infrastructure facilities to be designed by multidisciplinary teams using processes such as those briefly described above. For example, the design and development of the £9bn 2012 London Olympic Park was undertaken by the Olympic Development Authority, a non-departmental public body led by a team appointed directly to the Authority. The Park was delivered on time, within budget and to a high standard.

We hear about infrastructure projects that have serious problems. The most prominent current examples are the 2017 Grenfell Tower Disaster and the Crossrail Project that is well behind schedule and over budget. On the basis of such evidence, it is not unreasonable to be sceptical about the potential for government projects to be successful. The reality is that the success rate for government infrastructure developments is high. Major highway projects, long span bridges, tunnels, etc. are designed and built often on time and within budget and with minimum disruption. Such outcomes are achieved by very careful focus on meeting the requirements particularly those associated with 'environmental impact, cost and risk'.

How would it be done?

To reduce emissions, the whole energy system, (i.e. all production, supply and use of energy), and the interactions among its parts must be must be taken into account. For example, if it is decided to convert to electric vehicles, the electricity system must be capable of meeting the extra demand. The Authority would be required to ensure that studies carried out to support decision-making take account of: all relevant issues, the interdependence of the parts of the energy system, energy efficiency, whole life whole system costs, information from predictive models, data analysis. risk analysis, pilot tests, etc. This is the essence of an engineered approach.

Proposals from the Authority should include measures to reduce, for example, the effect of energy price increases on (a) those who are not able to adapt to them and (b) on the economy. Also, there are many environmental issues that need to be addressed.

Decisions about energy production and use will affect markets and tighter regulation will be required. In some cases, it may be found that market signals will not deliver what is needed and other strategies may need to be adopted. The creation of a National Energy Authority does not, however, imply that any of the energy assets must be nationalised.

Conclusion

A project that had parallels with the achievement of the net zero goal is the Apollo Mission where, in the 1960s, the US Government, over a period of 10 years, allocated funding equivalent to about 2% per annum of the US GDP to putting people on the moon (Johnson 2006). The programme was engineered by NASA, a government body. It is interesting to note that if the Apollo Mission had been closed down due to say technology failures, the consequences would not have been all that dire – mainly a severe dent to US national pride. The stakes are much higher with the net zero goal. Not achieving that goal is predicted to result in serious environmental, social and economic consequences. Not properly addressing the risks in the measures taken to achieve the goal, such as allowing the electricity system to become unreliable, launching major projects on the basis of flawed information, or not addressing the effects of increasing energy prices, would also have devastating consequences.

The main objective in an engineered approach is to eliminate unsatisfactory outcomes. In the absence of such methods, failure to meet objectives is likely to be the norm rather than the exception.

References

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