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Biography. Iven Mareels is Pro Vice-Chancellor Innovation and Executive Dean at Federation University Australia. He is also a Director of the Australian Academy of Technology and Engineering, and a non-executive Director of Rubicon Water. Previously, he was with IBM, inter alia as Director of IBM Research in Australia (Feb 2018- Mar 2021); and Dean of Engineering at the University of Melbourne (2007-2018).

Iven received the PhD in Systems Engineering, Australian National University (1987), and the Master of Engineering (Electromechanical), Gent University (1982).
He is a Commander in the Order of the Crown of Belgium, and received the Centenary Medal of Australia for contributions to engineering education and research.

He is a Fellow of The Academy of Technological Sciences and Engineering; The Institute of Electrical and Electronics Engineers, the International Federation of Automatic Control and Engineers Australia, a foreign fellow of the Royal Flemish Academy of Belgium for Science and the Arts and an inaugural fellow of the Asian Control Association. Recently he also became a Fellow of the International Artificial Intelligence Industry Alliance.

Title: Systems Engineering for the New Grid

Abstract: The transition to net zero demands a reinvention of the electrical grid. Conceived in the late 19th century, the grid has expanded to span entire continents, and to serve more than 90% of the world population. It is an incredible feat of modern engineering that powers the world in a reliable, safe, and affordable manner. It is a key pillar of the world's economy. The apparent simplicity of frequency and voltage stability belies the true engineering achievement it represents.

As the world transitions to net zero carbon emissions, the grid is to be re-engineered. It is to change from a relatively small network of large point generators providing dispatchable supply to a vast distributed network of decentralized, largely uncoordinated power sinks into a network exhibiting much greater complexity in every possible aspect. Moreover, in order to minimize adverse climate change impacts, this rebuilding must be done in a fraction of the time it took to build it, and

because of climate change, the new grid must also be much more resilient to adverse weather events. This is a tall order. But there is more, as net zero demands more than just transforming the grid, it has to expand considerably beyond its present energy remit, as the present grid is only responsible for 40% of total emissions.

In this presentation, we revisit the grid from a systems engineering point of view, starting with a re-consideration of its spatial and temporal scales. This allows us to contemplate how a classical decentralized, self-organizing approach (based on distributed measurements) may in fact be feasible, provided there remains enough capacity in grid forming synchronous machines to maintain both voltage and frequency stability in a robustness manner. Unsurprisingly, in view of increasing dynamic complexity, new instability phenomena appear. A network with less synchronous, grid forming capacity necessitates a much stronger reliance on global communications, with networked co-operating sensors and actuators, which however undermines the resilience objective. Re-imagining the grid as a collection of weakly collaborating microgrids may offer new options. This section is illustrated by a recent study of how the Australian grid must transform to meet net zero in an orderly fashion.

Overall, as we navigate some of the recent literature, we formulate more questions than concrete answers, indicating a golden opportunity for the collective research community of power, control and AI engineers.