WHAT WILL AN ENERGY CRISIS MEAN FOR YOU?

Part 2: Our Essential Electricity System

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Prologue

***Y**ou wake early, too early for a normal morning awakening. It is eerily quiet, and unusually cold. It is dark in your bedroom, but there are the early signs of soft, pre-sunrise light entering the lounge area, beyond your bedroom door. Irritated by this unwelcome interruption to your slumber, you reach for the bedside lamp and press the switch... but the lamp doesn't light, so you try again, but still no light.*

Becoming more annoyed, and now puzzled, you reach for your phone from its charging base, and tap the screen. The display tells you that it's just a few minutes after six, and that the battery is nearly flat. There are also no mobile network or Wifi signals. You check that the phone charging lead is plugged in and switched on, and place your phone back into the charging base, but there is no response to affirm that the phone is charging.

Now a little agitated, you get up from the bed, and immediately shiver slightly as you feel the unexpectedly cold morning air on your bare arms and legs. Walking out to the lounge area, you switch on the lights... nothing... they are unresponsive. Try the television, and the radio, then your computer and the Wifi modem... nothing!

Perplexed, you pull the window curtains apart, only to be greeted by the shadows of a grey and darkened city. There is a strange stillness, and an unsettling silence. In the far distance, you notice a single bright spotlight above a particular darkened building, which you know is the hospital rooftop landing pad for the regular medivac helicopters which deliver their precious, suffering patients... night and day.

You resign yourself to the assumption that there must be a power outage. Never mind, you think to yourself, the power will be restored soon enough. Placing an empty kettle under the water tap, you turn the tap to fill the vessel… but there is no water!

Now irritated, you put the kettle down and stride into the bathroom and turn on the shower mixer… nothing!… as you had already expected. You resolve not to bother trying the toilet, the result will be what you can already deduce.

Then it dawns on you that the new EV in your charger-parking station in the basement might not be charged for your drive to work. And what about the new fleet of EV buses now used for public transport, will they be running? Will your office even be open for work? "Stop that silliness", you think, silently and sternly to yourself, the power will be back on soon, of course it will. Won't it?

With a sense of hopelessness, you sit down to think about things... like a cold breakfast, or donning some warmer clothing, or just going back to bed, perhaps.

Then you remember something that your now semi-retired parents mentioned some time ago. When you last called to "check in" with them, your mother mentioned that the electrician had just arrived to install extra power points in their bedroom and lounge, so that they had extra places to power their medical devices!

The memory jolts you a little. Why didn't you ask more questions about those devices, and the human conditions which make them necessary? So, what do they do in a power outage? You reach for the phone, again, but put it back in the charger base. That call will just have to wait until the power is back on.

But, what if the power isn't restored, soon? What if this situation becomes the "new normal"? The thought is too discomforting... you pick up a magazine, looking for a suitable distraction...

Introduction

It's time that we all became acutely aware of just how essential our *'real'* essential services are to our lives, and that, at the top of the tree must be the supply of electricity, because it is electricity that underpins almost every facet of our technology-driven and technology-enabled lives... including the full range of other vital essential services that cannot be delivered without it.

From our telecommunications systems, to our hospitals, our lighting, heating and cooling, our transport services and traffic management systems (whether road, rail, air or sea), municipal utilities such as water supply and sewerage recovery, effluent treatment and disposal, manufacturing industries and commercial enterprises.

The bureaucracies and agencies of government, our services sector including food production and processing, homes and schools, local medical centres and pharmacies, the corner stores and cafes just down the street, and on and on... they're only there for us if the power is also on for them.

And don't forget the range of home-based medical devices which are essential to the health and wellbeing of many vulnerable people in our communities.

How many people have an expensive battery backup unit (often known as an uninterruptible power supply, or UPS), primarily as an alternative short-term power supply for their home office or critical medical equipment, which they could also use for their phones and other vital devices (for a short time, at least)?

And how will our "cashless" society and the rest of us manage without functioning EFTPOS and ATM facilities?

We have become inured to the fact that, for many decades now, we have been blessed with an electricity system that is always there for us, always available, always just at the flick of a switch.

In many, if not most instances, it must always be on. For most of us, the idea that one day it might not be there, doesn't even cross our minds. That's simply not in our broader experience, so far. We have easily forgotten, or just failed to notice, that many people have already suffered this sudden and unexpected loss.

Today, we're facing demands for far greater quantities of electricity than we have ever known, primarily to feed the voracious energy demands of rapidly emerging artificial intelligence technologies.

But the utopian reality of electricity supply is now rapidly changing. It may not be a reality any more. There will be a new reality. Many of us have already experienced at least a small taste of the future, what we can expect, if we allow the determined and active destruction of our base load electricity system to continue.

We all know that we are in the throes of an enforced transition to so-called renewable energy sources. It's claimed to be what we absolutely must do to save the World. It is literally in our faces, every day, all in the name of "climate change mitigation" or "human-induced CO_2 emissions reduction".

The *'new direction'*, is in fact taking us rapidly backwards, back to a time when we only had solar energy to warm us a little during the day, when we only had dry grass and wood, to make fires for cooking and heating (and eventually also for toolmaking).

When we only had wind energy to sail rudimentary water craft for fishing or foraging in newly discovered lands, and when we eventually worked out how to harness the power of water to do mechanical work. All this at a time in our evolution when we were no more than small groups of hunter-gatherers.

We have advanced to now regard these life support necessities as "*old tech"*, and claim that we are moving forward with *"new tech for our renewables future – solar, biomass, wind, wave and water"*. Does the irony resonate with you?

The claim is chanted ad nauseum, that all of our fossil fuel energy sources must be replaced – immediately, if not sooner – with *"clean"* and *"free"* energy from natural sources such as the sun and the wind, along with a few lakes for hydro power, if we have them. But, is this really the truth, and the answer for our future?

Are we really intending to harness old technologies in order to sustain and advance our now vast populations, with voracious energy appetites, people who are mostly utterly dependent on highly developed and ever advancing new technologies, who are now absolutely dependent on the constant availability of massive quantities of energy – most predominantly in the form of electrical energy?

As reported recently in Nature, some of the World's biggest technology corporations are in the process of acquiring or building new nuclear power plants, specifically to supply their own AI facilities*. [David Castelvecchi, Will AI's huge energy demands spur a nuclear renaissance? Published by Springer Nature, 25 October 2024]*.

The trend for collaborations of this kind, between *'Big Tech'* and nuclear energy providers, began with the signing of a contract between Microsoft Corporation and Three Mile Island's Constellation Energy in September 2024.

This agreement involves recommissioning the nuclear power plant's recently mothballed Unit 1, which is now expected to return to service in 2028, with a 20-year power supply deal for Microsoft. *[Myles McCormick and Jamie Smyth, Microsoft in deal for Three Mile Island nuclear power to meet AI demand, reported by Associated Press, 21 September 2024].*

But, what about the rest of us: What is the point of *'Big Tech'* having their own power plants, if the rest of us don't also have our normal base load electricity supplies? Their technology, including AI, would be useless to the rest of us if we, too, don't have a reliable base load electricity supply.

Do we subscribe to the same vision that was once proudly proclaimed by Australia's recent Chief Scientist, ***Dr Alan Finkel,*** that he envisaged a vast array of solar PV panels and giant wind turbines right across inland Australia? Did his *'vision'* also include the very necessary dense spider web of transmission towers, power lines and remote switchyards?

Most of us would see such a vision more as a nightmare, a "War of the Worlds" scenario. Hello Orson Wells and company, you must be chuckling with glee.

In a laconic and amusing recent article, "The Future of Energy", Issac Orr and Mitch Rolling explain how renewable energy sources were our past, fossil fuel sources are our present, and nuclear energy is our future. *[Published by the authors on 26 October 2024, at https://energybadboys.substack.com/p/the-future-of-energy].*

Their opening declaration sketches a familiar story: *"Many people seem to think the future holds an inevitable shift away from fossil fuels toward solar panels and wind turbines, but this perception is incorrect.*

"As California demonstrated in mid-August, these technologies are not up to the task of powering our lives, and pretending otherwise is both naive and dangerous.

"California politicians spent decades passing legislation mandating ever-increasing amounts of wind and solar on to the electric grid. On August 14 and 15, 2024, these policies came back to bite them in a big way."

This is a conundrum being shared across many jurisdictions from the UK to Australia and New Zealand, and people living in the north-western NSW region of Broken Hill, have recently become the latest victims of the seriously ill-informed and utterly misguided policy positions of politicians (driven by the purely commercial self-interests of the renewables sector), leaving the region abandoned to a zero-energy fate.

In a recent paper presented to the Ontario Society of Professional Engineers (OSPE), a Canadian expert in the fields of climate science and nuclear power generation, transmission and distribution, ***Dr Charles Rhodes***, warns:

"Present government-led climate change mitigation policies are not founded in physics and are ineffective. Instead, we mostly need sustainable nuclear power, synchronous power generation and capacity-based electricity billing.

*"When these things are in place, the electricity grid system will be able to accommodate about **20 per cent** (%) of extra energy contribution from wind and solar generation.*

"A larger fraction of wind and solar generation is only economically viable if the geography of a nation supports large amounts of hydraulic energy storage." *[Dr. Charles Rhodes, 'Nuclear Mitigation of Climate Change', Xylene Power Ltd, Sept 2024].*

This is important advice, so let's start by examining some of the important knowledge... the information which will help us to understand what's right and wrong, and what's best for our future, and for our children's future.

We really must understand these critical factors, in order to keep our thinking in order – factual and rational – to enable us to make and demand informed choices from our elected governments and institutions.

That "Net Zero" cliché actually means **zero base load electricity**, if we don't get smart – and fast!

For a better understanding, it will be helpful if we consider some of the **key and irrefutable facts** about power generation and transmission, which will then enable us to examine our options for the future in a reasonably informed and rational manner...

Our Base Load Power System

Firstly, our primary power generation, transmission and distribution systems are underpinned by what is defined as a ***base load*** alternating current (AC) electricity system – or what is commonly referred to as 'the electricity grid' or 'the power grid'.

There is far more to our electricity system than just *volts*, or just *megawatts*, or just *"switching on a power station"*, or merely having a wind turbine rotate its massive blades *"just one turn and supply xx thousands of houses with electricity" (the xx figure varies with the size and capacity of the wind turbine, of course)*.

Flippant statements such as these are inadequate, incorrect and misleading references, which are used far too often by people who do know better (or should), or people who simply have no idea (and don't care).

The mysteries and magic of electricity and our electricity grid are actually a very interesting and exciting topic to explore, even if we only scratch the surface, so let's venture out on a quick tour...

If we consider the *qualities* of a ***base load AC electrical system***, we are primarily thinking about Volts, Amps, reactive power (VAR's), and frequency (Hz), for the moment ignoring other factors such as load (MW), phase sequence, phase angle and so on, factors which are not critical to this conversation.

Of these factors, ***frequency*** (Hz), poses an interesting conundrum, when considered in relation to so-called intermittent renewable energy sources (and the term "*renewable*" is arguably another conundrum in itself, along with the terms "*fossil fuel*" and "*sustainable*", but that's for another conversation).

As should be well known – but is rarely acknowledged in public discourse – our ***base load*** system is required to operate at tightly defined parameters, and frequency is just one of them; viz, 50 Hertz (Hz, or cycles per second), in Australia, or 60 Hz in North America, for instance.

Every time-based domestic, commercial and industrial process depends on a frequency-controlled '*clock*'. In fact, our whole World depends on this. But where does this multi-faceted electricity supply come from?

Synchronous Generators

In the first instance, ***'synchronous'* generators are absolutely critical** to a fully functioning base load power system. They, alone, establish and sustain the frequency of the grid – the time and timing.

In very simple terms, a synchronous generator is one which rotates at a fixed speed, while being driven by a powerful external force (a large steam turbine, or a large gas turbine, or a very large hydro generator, for instance). It is the massive ***inertia*** of these machines which stabilises the network, in any normally operating electricity grid.

The machine maintains the fixed speed (the synchronous speed, in Hz), regardless of changes in the load demand (from either MW's, Amp's or VAR's, or all of those factors together), on the electrical system to which it is connected, mainly due to its immense ***inertia*** – the massive and physical rotating force that the machine exerts.

This can be likened to the flywheel on a car engine, which gives the engine momentum (*inertia*), to carry the crankshaft on to the next ignition phase of a cylinder. Inertia physically *'smooths'* out the rotation of the engine.

If the external '*load*' from the grid increases, the turbine governors open to drive the generator harder, and thereby generate more electrical power, while still maintaining their synchronous state – the fixed speed. And vice versa for a load decrease on the grid.

This is the same principle that is applied in the cruise control device of a car, but only controlling straight-line velocity, in this instance (as just one simple example of the principle). However, and in a grid frequency control system, there are a number of critical parameters which are monitored and compensated in the control system.

The laws of science and engineering tell us that a system can only be controlled by the strongest input to the system (but none of us should need anything other than common sense to know that – we know that the strongest force usually always wins, and that this can sometimes also mean that the loudest voice is the only one heard).

Hence, and in theory, we must have at least one large AC generator controlling the system – being the largest generator in the system. But this is a gross oversimplification, just to make the point.

'Controlling' here means responding quickly, correctly and smoothly to changes associated with voltage, current, reactive load, frequency, and power (MWe load), and especially to any unexpected major system disturbances (sudden 'swings' in the movement of an electrical load), in order to maintain the equilibrium of the system – and especially to maintain the frequency within a very tight range around the target frequency (50 or 60 Hz).

In a complex system such as the electricity grid, a change in any single critical input parameter will produce changes in the other critical parameters which feature in our electricity system. Intriguing, isn't it... but it's real, too!

In reality, and in a large electricity grid system, a number of large base load synchronous generators will be operating together, electrically, in order to maintain effective control of the base load power system – what is known as a finite network of synchronous generators, that are all operating in ***frequency control***.

Each synchronous generator will be controlling frequency within a specified *'deadband'* (a control range which will be plus or minus a finite percentage above or below the ideal frequency), and the *'deadband'* will be larger or smaller from one generator to the next.

This means that only some generators start to react to a system frequency change earlier than others, while others begin to react at a later point. In this way, not all generators are responding to a single change and in exactly the same way, thereby *'smoothing'* the control response so that consumers are not adversely affected by unnecessarily large frequency changes.

The main base load synchronous generators are very large, steam, gas or water-driven machines constructed of many tonnes/tons of heavy metal, which are connected to even larger steam turbines (also weighing many tonnes/tons), and together rotating at 3000 RPM in a 50 Hz system, or 3,600 RPM in a 60 Hz system (and 1,800 RPM in 4-pole Generators, and so forth).

Yes, it is a mighty and fearsome vision, if you don't know and understand the machines and the process. Those of us who have worked with these machines, regard them as *awesome*, because we understand them intimately and respect them absolutely.

Steam turbines are driven by massive quantities of thermal energy, in the form of superheated steam rushing through the thousands of turbine blades at very high pressures, temperatures and velocities.

In simple gas turbines, we're talking about very hot and high-velocity gasses produced by what we know better as jet engines, but these land-based versions are on an industrial scale.

And in a hydro turbine we're talking about huge volumes of water flowing through large water turbine blades, with the water itself weighing many tonnes/tons.

These machines are controlled in a very precise manner, by the most sophisticated computer-based control systems and digital-electro-hydraulic governors (the critical control valves which regulate the flow of energy into and through a turbine). It's relatively easy to visualise how the massive ***inertia*** of these machines is able to stabilise the network in a normally operating system.

Conversely, ***asynchronous*** and intermittent renewable energy generators (and other stationary electrical control devices), have little to no physical rotational inertia. Accordingly, **asynchronous generators cannot control frequency or any other forms of system instability** (voltage, current, load, reactive power and so forth);

We should note here, just in case you're wondering, that we haven't mentioned a lot about the role of synchronous hydro (or hydraulic) power generators, as they are not a large part of many grid systems, depending on the topography of the land and the reliable availability and replenishment of water catchment and storage systems.

Of course, large synchronous hydro power plants certainly have great inertia, and are predominant in regions such as British Columbia and Quebec in Canada, and in Norway and New Zealand, as other well-known examples.

There are numerous ways of controlling reactive power (VAR's), a vital "ingredient" of our base load system – the "*hidden*" energy which creates and sustains the magnetic couplings that drive large ***synchronous motors*** which underpin our mining, steel-making and other large industrial and smaller commercial processing and manufacturing industries.

These industries are at the heart of our ***economic wellbeing***, including valuable employment opportunities – both directly and indirectly – together with export revenues and government royalties, and sustaining the economic wealth, wellbeing and resilience of our nations (often shielding us from most of the economic issues that do arise in other parts of the World).

Some of these supplementary methods of managing VAR loadings involve assistance from extensive transmission lines, reactor banks and capacitor banks, in addition to actual power generation plant.

Hydro sets which are connected to the grid, but not actually generating (they are acting as large electric motors, exerting just their physical rotating weight and inertia), are also a very good asset for helping to manage reactive power, and are known as being a *"synchronous condenser"*, in this mode of operation.

While discussing transmission lines, we must note that the new grid networks, constructed specifically to service new and remote **intermittent renewable energy generators, also contribute enormous additional cost to a network**.

This is because they are some distance from existing networks and electrical substations, and also because they require the installation of huge reactive power and other stationary electrical control banks to offset the extra VAR loadings associated with the new networks.

Of course, this involves far greater costs, also exacerbated by the establishment of new easements for access, together with ongoing annual compensation payments to landholders – *ad infinitum* – in perpetuity.

No wonder then, that **the proposed new renewable energy networks are expected to cost billions to install and maintain** (and then to replace when their relatively short equipment lifespans expire), and for landholder compensation costs being paid in perpetuity.

As intermittent power generators, wind turbines, wave generators and solar panels are necessarily **'*asynchronous'*** generators. They cannot generate power unless there is a synchronous system for them to connect to.

It is the synchronous grid which provides them with both the speed control and the initial electrical energy which enables them to actually connect to the grid and to then generate electricity.

As we saw recently in NSW, the sudden loss of transmission lines due to high winds resulted in the total loss of power to a number of regional communities, including the famous mining centre of Broken Hill.

Standby backup diesel-fuelled generators failed when desperately needed, and an extensive wind farm plus solar PV 'super-array', and a 'mega-battery', could not function without having a synchronous grid connection to stabilise the regional network.

Even when they're not generating, wind turbines require electricity from the grid to maintain adequate operating oil temperatures for the turbine and generator bearings, and for generator heating to avoid internal condensation and the corrosion of critical electrical components (as do most other turbine-generator power plants).

Furthermore, and in order to maintain effective control, a functional base load AC system must comprise of a major proportion of large 'synchronous' generators.

There cannot be a functioning base load system which is solely or mainly comprised of intermittent asynchronous power generation sources. Accordingly, then:

"***A secure base load grid should obtain no more than 20 percent (%) of its energy from asynchronous power generation sources***, *noting that intermittent generation typically has a capacity factor of about 33%.*

"Hence, intermittent generation that on average supplies 20% of the system energy might meet as much as 60% of the system demand at a time when the wind is strong and the sun is shining brightly.

"However, and under those circumstances, the fraction of synchronous generation may not be sufficient to maintain grid stability." *[Dr. Charles Rhodes, 'Synchronous and Asynchronous Electricity Generation', published by Xylene Power Ltd, 14 August 2023].*

Despite the fact that it only has 75% of renewable energy capacity (according to its own records), the State government of South Australia recently boasted that almost 100% of the State's demand was met with renewables. But, there are at least two inconvenient and unstated truths:

What was **<u>not</u>** noted was the important fact that the stability of their electrical system would only have been possible due to the State's grid connections to the much larger East Coast Grid (which comprises of several very large coal-fired, gas-fired and hydro synchronous generators).

What was also **not** noted is the fact that South Australia has the highest-cost electricity and the weakest state grid in the country, and is the only State in Australia to have suffered a State-wide blackout!

That debacle occurred not long after the State's coal-fired power plant was detonated with explosives and destroyed, in what can only be described as a Government-led orgy of delusional ideological fervour?

It should be of great concern that many decision-makers and their advisors assert that we must aim for a power grid which is mostly supplied by intermittent renewable energy generators which will deliver *"cheap electricity"* to homes, businesses and industry. But, this is a seriously misleading – and grossly incorrect – assertion.

As Dr Charles Rhodes explains: *"The problem is the use of kWh (a measure of energy consumption), to value the output from an intermittent generator.*

*"In reality, the value of electricity is based on both **'reliable capacity'** and '**energy**'. If the reliable capacity is zero, the energy component is only worth the value of fossil fuel displaced.*

"Typically, the energy component of the output of intermittent generators is 10-times over-valued. For the same reason, net metering usually over-values the energy inserted by consumers, also by about 10-times.

"On top of that problem are the costs of providing network protection in the presence of bi-directional power flow." *[Dr. Charles Rhodes, 26 July 2024].*

Importantly, Dr Rhodes is talking about what is known as the **reliable** and **dependable** 'capacity' of a generator to supply electricity (energy), when it is needed – not only when the wind blows, the sun shines or the ocean moves.

This is referred to as the *"**capacity factor**"* of a generator. Obviously, intermittent asynchronous generators will have a capacity factor of **zero**, because they can never guarantee an electricity supply – they will never be reliable and dependable sources of electricity.

Another important point to note about our large base load power plants is that they are designed to operate continuously at ***peak efficiency*** (which is usually their maximum continuous rating, or MCR).

They are not designed to operate in what is known as ***load-cycling*** mode, where they are required to reduce load for indefinite periods (in other words, to operate well below their most efficient level), or even to shut down for indefinite periods, in order to accommodate intermittent renewable power sources.

Put very simply, it takes a very long time, and very careful management, to start a large thermal power plant (boiler-turbine-generator), and to only very gradually raise the temperature of a huge mass of metal elements – along with the water and steam which circulates within the plant – up to its specified operating temperatures (generally around 540^{o}C/1004^{o}F, in large modern steam power plants).

The intention of the designers and constructors is that the operating temperatures must then be carefully maintained, because any heat fluctuations will result in heat-induced stresses which, at the very least will reduce the "***fatigue life***" of metal or, at worst can result in failure of the power plant.

Metal fatigue can result in ***catastrophic failure*** of a power plant, at great personal risk to engineering, operating and maintenance staff within and around a thermal power station.

A large base load synchronous power plant that is forced to endure repeated cycles of heating and cooling, due to load-cycling – operating in an uneconomical manner and at lower efficiency than it is capable of delivering – will be costing much more, just to generate at a lower output.

Not only is this highly uneconomical, but it is also very damaging to large power plants in a number of critical plant areas, often resulting in extended outages for unplanned maintenance and refurbishment, and thus incurring even greater losses. *[Steve Hesler, Electric Power Research Institute, "Mitigating the Effects of Flexible Operation on Coal-fired Power Plants", published in 2011 by Power Magazine, USA].*

Under present load scheduling rules, intermittent renewable power generation is prioritised (or *'preferenced'),* over base load sources. This forces our large power plants to run at significant losses, often also forcing their early retirement (for either financial or mechanical – *fatigue life* – reasons, or both).

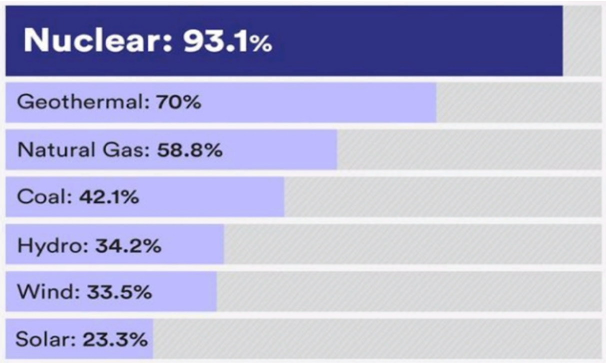
In the end, we all pay a huge price for these unnecessary, undesirable, substantial and significant losses.

Dr Charles Rhodes further notes that: *"In North America, almost all successful nuclear power plants are funded by Power Purchase Agreements, which factor in both **capacity** and **energy** (kWh). In essence, these agreements are "take or pay", where the plant owner is paid whether or not the electricity generation 'capacity' is used.*

"This results in nuclear power being dispatched first, which has the side benefit of minimising CO_2 emissions." *[Dr. Charles Rhodes, 26 and 29 July 2024].*

This is the opposite of the prioritisation of intermittent, non-dispatchable, asynchronous renewable electricity generation sources that is legislated in Australia (at the direct cost/loss of base load power generators).

The reality of this arrangement is illustrated in Capacity Factor records published by the Office of Nuclear Energy, within the US Department of Energy, as shown below (based on data from 2023).



The agency notes that *"Capacity factor measures the power plant's actual generation, compared to the maximum amount it could generate in a given period without interruption."*

And also, that *"US nuclear power plants operate at full power more than 93% of the time, and have held capacity factors above 90% since the early 2000's."*

[Table courtesy US Department of Energy / energy.gov.ne, 2023]

This is a clear illustration of how a healthy base load electricity system should be operating, and how effective nuclear power generation is in maintaining a fully-functional base load electricity supply, and in reducing overall CO_2 emissions – potentially without the need for any other form of electricity generation.

And yes, it would be a massive saving if we were to do away with all of the rest! So, who wants far cheaper power bills? Sorry, that old inefficient, unreliable and costly technology which certain people crave (like solar, wind and wave), is simply not needed, and should be consigned to the waste heap of history.

Power purchase agreements (PPA's), have long been used in Australia for a range of services, all originally aimed at sustaining the base load electricity system in the event of the unplanned loss of other critical synchronous generation sources. Effectively a strategy to assure the reliability and resilience of our base load electricity system.

The combination of these services is known as **'dispatchable power'**, because the services can be guaranteed, at any time, by the synchronous base load electricity generator. Conversely, asynchronous electricity generation cannot be guaranteed. On many days there will be no wind and no sun (due to heavy cloud cover and rain), and there is never any solar at night.

In Australia today, however, and in many other nations, PPA's are commonly and irrationally associated with **non-dispatchable** intermittent asynchronous generation sources, and most particularly with offshore wind turbine projects (the costliest form of them all).

In other words, generators with **zero capacity factor** are being subsidised by taxpayers and consumers, simply to be in place, regardless of whether they generate useful electricity or not. Dependability, frequency and resilience are not a factor in these arrangements – in fact, they are a gross oversight, and a bare-faced denial of the facts.

Asynchronous Generators

Yes, we have already been talking about asynchronous generators (in relation to synchronous machines), but what are they as another form of electricity generation?

An **'*asynchronous*'** generator is one which is either static (like solar PV panels), or that does not have a fixed rotational speed unless it is electrically 'locked-in' (connected) with the synchronous grid – in which case its speed is set by the external force which is exerted by the grid, and this is what then enables the asynchronous machine to generate electricity.

Accordingly, **asynchronous generators cannot generate without being connected with a functioning base load synchronous electricity grid, and they certainly cannot set and control frequency**. This is the case, regardless of what type of asynchronous generator is considered (solar, wind, wave, etc).

Once connected with the power grid, asynchronous generators are relatively tiny machines which physically and electrically cannot exert any meaningful form of control. They do not exhibit a strong inertia. And, **having too many asynchronous generators will be detrimental to the grid, in critical ways**.

At a domestic level, and in the case of a grid power failure (a total failure of the electricity grid system), many people believe that their rooftop solar PV panels will continue to supply their home with electricity. As noted above, this is not the case (unless the home PV solar system is set up with a battery and a grid isolator).

With no synchronous grid available, a simple home solar photo-voltaic (PV) system cannot supply electricity as it is automatically disconnected when the network power is lost.

Further, if the power outage has occurred as a result of a network fault, then the last thing that the network operator wants is for uncontrolled electrical energy to be randomly supplied from other sources (such as rooftop PV panels).

This could put the lives of electrical workers and members of the public at risk, and also possibly adversely affect network protection systems (hindering reconnection and re-energisation operations, at the very least).

The only way that a home solar system can continue to operate is if it is supported by a battery storage system, together with a network isolator (which physically separates the local supply network from the household system).

When network supply is restored, the home solar system will then need to be re-connected with the network.

An additional issue is being experienced where large solar PV installations are sited in remote regions, and then connected to the existing lower-voltage power distribution lines.

These regional networks are generally designed as one-way supplies (from the origin to the remote user), and are not set up for the 'reverse flow' of electrical energy created by intermittent asynchronous renewable generators.

Needless to say, ***"the network costs of supporting bi-directional power flow are huge"***. *[Dr. Charles Rhodes, "Synchronous and Asynchronous Electricity Generation", published by Xylene Power Ltd, 14 August 2023].*

This is only part of the reason that the proponents of renewable energy projects require massive government subsidies (taxpayer funds), in order to purchase, build, operate and maintain their projects.

While many people are aware of the *'incentives'* to bring these proposals to reality, most are blissfully unaware that the need for massive subsidies continues into the operational phase of these projects.

An illustration of the magnitude of 'incentives' offered by governments, on behalf of their suffering taxpayers, is revealed in a recent report by Net Zero Watch UK in their Samizdat Newsletter of 14 November 2024, that:

Another windfarm surpasses £1 billion in subsidy payments!

The Beatrice Offshore Windfarm has become the fourth windfarm to have received more than [GBP] £1 billion in subsidy payments. The landmark was reached in just its seventh year of operation, suggesting that it could reach £2 billion over the course of its subsidy agreement.

Beatrice, situated in the Moray Firth, cost £2.2 billion to construct. Thus, consumer levies will pay for almost the entire cost of the windfarm. The profits are ultimately shared by SSE Plc and the Danish investment house Copenhagen Infrastructure Partners.

Net Zero Watch UK has condemned the waste. Its director Dr Andrew Montford said: *“This level of subsidy is obscene. The Westminster machine is hosing down the green lobby with our money. The consumer interest is nowhere to be seen.”*

Richard Tice, deputy leader of [UK political party] Reform UK, said: *“Renewable energy subsidies are making people poorer with higher bills. Businesses are less competitive, meaning less growth and fewer jobs. Reform, would put a windfall tax on all renewables to the value of the subsidies. We need to copy the US plan and ‘drill baby drill’ to make people better off.”*

The report also noted that:

1. The other windfarms that have received more than a billion pounds [Sterling] in subsidies are:

- *Walney Extension £1.7bn*
- *Hornsea One £1.6 bn*
- *Dudgeon £1.2 bn*

2. The CfD [Contract for Difference], scheme as a whole has paid out a net £9.2 billion since 2016. Payments are now running at around £200 million per month.

3. The subsidy figure is revealed in data released by the Low Carbon Contracts Company.

In a later newsletter (20 November 2024), and reporting on what has been a 10-year investigation, so far, Net Zero Watch UK again presents evidence of clear conflicts of interest involving government ministers and some of their top-tier advisers (all public servants).

The issues arise where government ministers and their close associates in the bureaucracy have made generously favourable funding decisions on behalf of renewables entities in which they also have a personal interest (declared or not). These interests include grid-scale batteries and hydrogen production facilities.

Net Zero Watch UK director, Dr Andrew Montford, additionally notes that: *"Hydrogen companies will get both capital subsidies and revenue subsidies.*

"The Capital subsidies may represent the majority of the construction cost of the electrolysers. On the revenue side, the subsidy will allow hydrogen, with a production cost of £240/MWh, to compete with natural gas at £80/MWh.

"In other words, the subsidy might be expected to be around £160/MWh. £2 billion is expected to be shared between 11 small electrolyser projects."

Would anybody expect that these examples won't be repeated in Australia, or in any other nation?

The bottom line: Taxpayers and consumers are paying not only for energy supplied, but also for the energy guaranteed but not supplied, and also to meet revenue (profit) expectations.

What we don't know, of course, is how the *'real'* capacity-to-supply of a renewable energy project is determined, how realistic the claimed capacity figure really is, and how revenue and profit are fairly and objectively decided.

In Australia, the Electricity Network Operator (AEMO), camouflages a CfD as being *"Long-Term Energy Service Agreements – the innovative contracts accelerating the NSW energy transition"*. *[aemoservices.com.au].*

For the taxpayer and electricity consumer, these examples simply confirm that we are all underpinning both the capital and operational costs of renewable energy investments (including wind farms, wherever they are, and extending to energy storage systems and so-called *'green'* hydrogen production), and also that we are guaranteeing the present and future profits of the project proponents and operators.

Additionally, we are also subsidising the massive cost of new electricity networks to connect these often remote renewable generators to our national grid system. Our largest and enduring employer group, small businesses, cannot even dream of winning financial support and guarantees of this kind.

We also note that, despite carrying the highest state debt ever known, the State Government of Victoria recently committed to a vast offshore wind farm project in the Bass Strait. Other state governments are also considering schemes of this nature, despite the evidence of their cost and unsustainability being experienced around the World.

In a comprehensive report for the Weekend Australian newspaper, environment editor Graham Lloyd says that offshore wind turbines are sold as a way to bypass hurdles for renewables. Amongst a broad range of observations, he notes that:

"In the world of renewable energy that hankers for the status of energy superpower, bigger is better. And it doesn't get much bigger than offshore wind. Fixed or floating, offshore wind is being sold as a new paradigm that will get around many obstacles found onshore, with better and more reliable wind availability and speeds, and fewer neighbours to annoy.

"The trade-off is highly complex engineering, new environmental considerations, and harsh operating conditions. Despite the big ambitions, reality is starting to bite. Costs are proving to be higher than expected, and reliability less than desired. Increasingly, the endgame globally is becoming a contest between offshore wind and nuclear.

"In a wakeup call for Australian politicians, one of the world's biggest energy technology companies, GE, says the cost of offshore wind must be compared with new nuclear, rather than onshore wind or solar." *["Throw Caution To The Wind", The Weekend Australian Inquirer, 2-3 November 2024, page 35].*

Of course, much of the factual and concrete evidence covered by Mr Lloyd is either ignored or denied by the government (and the renewables sector), and its energy minister blindly parrots the claim that:

"Offshore wind represents a huge opportunity for regional Australia, providing reliable renewables to power homes and heavy industry while creating highly skilled jobs and well-paid jobs now and into the future". Sadly, his delusion is pervasive, and knows no bounds...

In another article, Mr Lloyd also reports that, at the present COP29 summit, the energy minister has bluntly withdrawn Australia from the Generation IV International Forum (GIF), thereby closing an invaluable door to nuclear energy research collaboration.

Why? Because he maintains that Australia has no plans for a civilian nuclear industry! *['Nation's technological edge is about to get a lot duller', Weekend Australian Inquirer, 23-24 November 2024, p39].*

This is an ugly and blatant snub to Australia's allies, to the Australian Nuclear Science and Technology Organisation, and to the respected Australian scientists and engineers who have worked closely on the development of the new Generation IV advanced nuclear power technology since 2017, when the GIF was established.

It also sends a very negative signal to budding science and engineering students who might have been interested in pursuing a career in this field. In the long run, it will hurt Australia. The truth is, it's the minister who doesn't have any plans for nuclear energy in Australia's future.

An action such as this reeks of ignorance and childish pettiness, and denies Australian access to advanced technological research opportunities. Such conduct should have no place in the leadership of any nation. Energy Superpower Be Damned! We all enjoyed a rosy energy future before this minister came along.

Australia-based website, *Energy Matters*, presently lists 10 *'independent'* government funded renewable energy instrumentalities, all dabbling in the same publicly funded sandpit. *[https://www.energymatters.com.au]*

One of these, The Australian Trade and Investment Commission, on its website uses bold headlines to brag that the Australian Government, in its budget of October 2022-23, committed AUD$25 billion to clean energy spending.

In an AAP report of 16 November 2024, correspondent Ben McKay notes that "the Australian Government is partnering with Pacific nations to improve their energy security with a $125 million investment in renewables". This was announced at the COP29 United Nations climate summit.

While we should note that placing the words *'energy security'* and *'renewables'* in the same sentence represents an oxymoron (along with *reliable* with renewable, or *dependable* with renewable), we can only think that this funding may have been part of the $25 billion noted above. But, is it?

The evidence emerging from monitors such as Net Zero Watch UK, and others, is a clear warning that we cannot have confidence in what we are told, but we can be confident that there will be a great deal that we won't be told.

Without massive subsidies, renewables projects will never be viable, or sustainable. But, nobody in Government is listening, or is interested in learning, or is open and honest on our behalf, it seems.

Do politicians and bureaucrats ever consider what taxpayers and consumers can reasonably afford to pay for our essential electricity services, and also for Government largess, especially in the present environment of falling *'real'* income and rapidly rising prices? Clearly, and in an arrogant display of egotism, they don't.

In another of his excellent and well-researched articles on the subject, published in the Weekend Australian, correspondent Chris Uhlmann recently reported on *"The Astonishing Cost of Net Zero"*.

His lede was based on a favourite claim of the Australian Government's energy minister that *"the sun and the wind don't send us electricity bills"*, to which Mr Uhlmann added, *"but electricity retailers do – and they're big ones"*! Mr Uhlmann points out that:

"It is impossible to overstate the stakes if the energy transition runs off the rails. Electricity is civilisation's nervous system; without it, everything will collapse. What is happening is akin to conducting a proof-of-concept experiment on an incubator with a child inside. And red lights are flashing on energy transitions here and around the world.

"In Australia, the target for the eastern grid is huge: The government wants 82 per cent of generation on the National Electricity Market to come from wind, solar and hydro power in the next six years. That's more than double what it is now.

"In fact, the gap is bigger than it first appears, because the maximum generation capacity boasted by weather-dependent energy gatherers is no measure of the power they typically harvest. At best, onshore wind farms will deliver 40 per cent of their nameplate capacity.

"Solar panels sit at under 30 per cent. So at least twice as much random generation must be built to cover the retirement of every reliable power producer."

In the course of his research, Mr Uhlmann found that *"...everywhere wind and solar displace reliable generators to become a dominant source of power, two things happen: electricity prices rise and energy security falls. The reasons are at once complex and simple. In essence, it's all about balance.*

"The iron law of a bulk electricity system is that supply must perfectly match demand, every second of every minute, 24 hours a day, seven days a week. That finely tuned balance is reflected in the system frequency. Energy gatherers cannot match power demand with supply because their fuel is literally as predictable as the weather.

"To turn occasionally available power into a reliable electricity system, the gatherers have to be connected to a complex and expensive life-support system that the old grid did not need. Wind and solar plants cannot set the grid's frequency, or maintain its stability.

"So essential system strength services that were once delivered as a byproduct of generating electricity also have to be recreated and financed."

What this commentary misses is the fact that **frequency and grid stability simply cannot be created and controlled by intermittent asynchronous generators**, or any other grid-scale electrical device, other than large synchronous generators (which always provided this capability as part of their services).

Mr Uhlmann continues: *"... the dirty little secret in the construction of the green grid is that it cannot work as an electricity system without gas.*

"Daniel Westerman, chief executive of the Australian Energy Market Operator... says gas will be essential to ensure the reliability of the grid – to 2050 and beyond – as the cost of trying to cover long periods of low wind and solar generation without it would be prohibitive... gas fired power stations are really required to back up the reliability of the grid. They are there as the ultimate backstop.

Mr Uhlmann rightly notes that: *"As a future grid dominated by wind and solar generation cannot form a reliable electricity system without gas, the fossil fuel's role is more* ***backbone*** *than backstop...*

"And, lest we forget, last year [the energy minister] told the world climate summit that 'fossil fuels have no ongoing role to play in our energy systems' if the Paris targets are to be met.

"One begins to wonder if the minister understands that words have meaning. The distance between what he says and what is real is as vast as the generation gaps [that his] decarbonisation ambitions are punching in the electricity system.

"There is another terrifying possibility that would explain this reality gap: that the minister, his staff, his department and all the states and territories [of Australia], that have been pushing ambitious renewables targets for a decade, have no idea what they are doing.

"That Australia's political class, and the bureaucrats who advise them are breathtakingly, stunningly energy illiterate. That they have been ruled by virtue signalling and not facts.

"Uniquely in the world, Australia has a capacity investment scheme which forbids investing in dispatchable capacity" [aka dependable and reliable synchronous power generation].

"For [the minister's] benefit, we will return to [AEMO's] Westerman: 'What we know is that, as we get to a net-zero system, it's really expensive if we don't have a dispatchable source like gas'. Again, for his benefit, his preferred grid does not work without gas. And, without gas, it will be even more expensive."

Sorry, gentlemen (and one minister), but there is another inconvenient truth (or four):

Firstly, **Australia does not have a domestic gas reserve**, and the gas companies have no interest in moving their focus away from lucrative gas exports and their export contracts (which generally extend beyond the next 20-years).

Secondly, gas prices are already too high for economic use in power generation and other industrial processes (such as fertiliser production, for example), as has already been proven.

Thirdly, practical experience indicates that a natural gas turbine exhaust contains Methane. This is such a strong greenhouse gas (GHG), that it often cancels out the benefit of converting out of coal. The net result does not mitigate climate change, no matter how extensively gas turbine generators are deployed.

Finally, and most critically, without either gas or another form of synchronous power generation, it will be much worse than merely "*expensive*"... **Our base load electricity grid will simply be non-existent... Zero!**

Has the minister considered how the grid might be restarted, or does he think that will just happen when the wind blows or the sun shines? Or has he just not considered either the certainty of the event, or the question of the need for its re-energisation (a grid restart)?

We would strongly suggest that the people of this Nation (and any other nation), absolutely have a right to know, and they need an iron-clad assurance, before any more damage is done in the blind pursuit of a renewables-driven net-zero target. Yes, ***"net zero"* means *"zero base load electricity"***, nothing more and nothing less!

And Mr Uhlmann's conclusion: *"In an electricity system, the term for a catastrophic event is cascading system failure. It begins with an initial fault which amplifies through the grid and ends in a wide system blackout. The lights can go out within a minute.*

"If the mob wakes up to the fact that what was promised by [the energy minister] can never be delivered, or the lights go out, then it [the government] will learn what a cascading system failure looks like when it is applied to politics. The government's lights will go out in a heartbeat." ['The Astonishing Cost of Net Zero', The Weekend Australian Inquirer, 16-17 November 2024, page 33].

And on the very next page of the same edition, another equally factual, informative and vital commentary from associate editor Chris Kenny: *"Truth time: nuclear power is the only solution to our energy dilemma"*. We will be canvassing that subject in Part 4 of our series.

In the Weekend Australian of Nov 30-Dec 1 (Inquirer Page 37), Mr Kenny offers a scathing commentary on what he headlines as "Climate gaslighting... ", noting that, not being content with telling voters that renewables are the cheapest form of energy just as they force prices up, and that they are reliable just as we are warned of blackouts, and spruiking a couple of warm days as being a heatwave, the energy minister claims that:

"The least reliable part of our energy grid at the moment is coal-fired power, that's just a statement of fact." Mr Kenny rightly calls-out this absurd claim as the minister emphasising a falsehood with an untruth. But, this is the garbage that most of the mainstream media seem to believe, and broadcast widely to an ill-informed and vulnerable public.

Mr Kenny noted that, at the time of the minister's statement, Network data showed that more than 70% of the electricity generation was being supplied by fossil fuels (more that 60% of that from coal).

As has been noted by other commentary above, a significant issue with wind, solar and wave power is that alternative **base load sources must be maintained to ensure the continuity of synchronous power supplies** (often known as *"spinning reserve"*, or *"reserve capacity"*).

But this is not a viable proposition for conventional power generators, given that they only earn revenue when they are selling energy into the grid network, at their optimum load capacity (or maximum continuous rating, MCR).

A current instance involves a large jurisdiction overseas where *"a dire need for base load generation is not being met because wind and solar are making it unviable for existing or new gas-fuelled base load sources. Consequently, the only choice for supplying future load growth is nuclear power"*. *[Dr. Charles Rhodes, ibid].*

Base load power stations are rendered unviable if they are forced to compensate for intermittent renewable energy sources by 'load-cycling' (frequently or constantly reducing or raising their power generation output), or by frequent shutdown and restart operations resulting from ever fluctuating and intermittent renewable generation sources.

It is equally unviable for consumers to subsidise the huge costs of forcing base load power plants into a mode of operation which is plainly incompatible with their design and purpose, resulting in their premature failure and/or retirement.

Private sector power plant builders and operators are not interested in arrangements that are not based on a realistic power purchase agreement (a guaranteed return-on-investment for their huge investment).

We also need to consider that *"**widely distributed renewable energy generation sources require a far more expensive transmission and distribution network**"*. *[Dr. Charles Rhodes, ibid].*

Leaders of governments and the renewables lobby also don't mention the relatively **short lifespans** of all asynchronous renewable energy generation plant and related equipment, and of battery storage systems.

All except hydro power plants which are, however, hugely costly to build and maintain, while still requiring some other form of synchronous base load generation as a backup for periods of low snow melt or low rainfall.

Life-cycle costs including concept development, final design, materials procurement and shipping, manufacture, transport to site, installation, testing, staff training, plant operation and maintenance, frequent retirement, replacement, demolition, removal and disposal, would reveal the true cost of reliance on any of these power generation options.

Cost assessments, when comparing the various forms of electricity generation, should also include the value of CO_2 reduction that they deliver (if any).

Solar and wind generators have a lifetime of about 10-20 years, and batteries are typically only of short duration, in both use and lifetime.

On the other hand, coal-fired power plants will last 40-60 years (depending on maintenance and load-cycling regimes), and nuclear somewhere in the order of 80 years (depending on reactor type, and the prevalent mode of operation).

So, What Are The Options?

Other than wind and solar, there are a range of presently popular options (although it's not correct to refer to any of them – bar hydro power – as being *"green"*, albeit the latter with widespread environmental destruction and habitat loss). Most are favoured only for their potential as renewable *'support'* technology or as *"transitional generators"* (as in the supposed *transition* to renewables). Let's consider some of them.

Energy Storage

Large, ultra-costly and relatively short-lived grid-scale battery banks, are a new and still largely unproven prospect. However, they are a highly inefficient form of energy storage and distribution.

And, let's not talk about their environmental footprint (from mines to processing and manufacture, supply and installation, to eventual disposal, after a relatively short life).

Although they can supply power to the system via inverters, batteries simply do not merit consideration in this discussion, for obvious reasons, but especially because batteries are not generators, and never will be.

Batteries are merely storage devices for power generated from other power generation sources, whether renewable or otherwise, and they are far from being *"green"*, by any stretch of the imagination.

If someone claims to be installing "a billion-dollar grid-scale battery of 100 MWh", we need to realise that capacity statement means either (a) 100 MW of energy for one hour, or (b) 1 MW of energy for each of 100 hours, or (c) somewhere in between that range.

Further, battery life is dictated by the number of charge and discharge cycles, and will be severely reduced by fast charging and discharging situations (mainly due to the higher levels of heat generated). Yes, they're really no different to a car battery, in relative terms.

Although there are presently six types of Lithium-ion batteries, experience now tells us that some of these battery types are a serious explosion and fire risk (especially those varieties based on Lithium-ion Cobalt).

A more reliable and safer form, Lithium-iron-phosphate batteries, have taken a dominant place in China's electric vehicle manufacturing sector, and the nation is said to have monopolised available supplies of these batteries. We should also note that:

"With regard to grid-capacity Liquid-metal storage systems, often touted as viable supports for intermittent (asynchronous) power generators, politicians are presently buying short-lived Lithium batteries for utilities because they are perceived to be cheaper and more efficient. However, the cycling life of Liquid-metal batteries is at least an order of magnitude better.

"The best feature of Liquid-metal batteries is that they can take an almost infinite number of charge-discharge cycles. If you have uncontrolled wind and solar generation running in parallel with thermal generation then, without this energy storage, the thermal generation is exposed to a lot of load cycling.

"A better method of operation is to run the thermal generation at a constant or slowly varying power level and use the Liquid-metal batteries to effectively filter the output from the wind and solar generation. Lithium-ion batteries should not be used in this mode because their charge-discharge cycle limits will quickly be exceeded.

"A side benefit of the Liquid-metal batteries is that they enable the network operator to increase the fraction of renewable energy on the grid. Liquid-metal batteries should be located within pad mounted, outdoor, air tight containers. It also may be prudent to surround them with bullet proof outer walls.

"A disadvantage of Liquid-metal batteries is that they have a higher standing loss. However, if that standing loss is a major issue, then the whole economics of the use of intermittent generation with battery back-up, must be re-examined.

"The independent and international Future Of Energy Initiative (FOEI), has examined this issue in depth for Texas, and the bottom line is that no battery system will meet Texas requirements in December when the average wind generation is low.

"A fundamental problem is that energy storage does not make economic sense with pure kWh electricity pricing. The availability of extra electricity during a period of shortage reduces the electricity price, which bankrupts the energy storage system owner.

"The only way to fund energy storage is via capacity payments (at greater expense to the consumer)." [Dr. Charles Rhodes, 26 July 2024].

Since their initial deployments almost 10 years ago, large grid-scale batteries have generally focused on high-power and short-duration applications.

For instance, the first battery installed at Hornsdale in South Australia, had a capacity of 100 MW/125 MWh, yielding a duration of just 1.25 hours. Subsequent storage projects in Australia and abroad typically sit within the one to two-hour duration range.

"The real issue is that the combined cost of sufficient batteries, together with the cost of intermittent generation and the supporting transmission networks, does not make sense with respect to the alternative cost of nuclear power." [Dr. Charles Rhodes, ibid].

A new report from Net Zero Watch UK warns that the expansion of grid scale batteries represents a major threat to urban areas because of the fire risk:

"Lithium-ion batteries are prone to so-called 'thermal runaway', and the resulting fires are highly toxic and hard to extinguish". The report further notes the *"...recent major battery fires in the USA and Australia, and considers how similar conflagrations might affect conurbations* [dense and expansive urban communities] *in the UK.*

"For example, the fire at Elon Musk's 'Big Battery' in Australia [near Geelong VIC, in January 2022, which burned for nearly four days]*, led to homes up to 9km away being locked down to protect residents from the fumes." [Fannon, John, 'Grid Scale Batteries and Fire Risk', Published by Net Zero Watch, UK, September 2024].*

Despite claims that *"new technologies"* are being developed that will support intermittent renewable energy generators to become the primary energy source for our power grids – and delivering the promised "*cheap*" electricity to everyone – the reality doesn't support these claims.

While governments are funding extensive (and expensive and taxpayer-funded) research in pursuit of this goal, grid-scale technologies do not yet exist, and are not even on our near horizon.

Development that is presently confined to computer-based simulators in universities or other commercial laboratories, is far from being a *'real',* grid-scale solution, and electronic equipment cannot deliver the essential stabilising ***inertia*** (or rotational force) of a large synchronous generator.

As noted above, existing technology which is in limited use (mainly to assist in managing the VAR loadings induced in transmission lines), is also exceedingly expensive to install, maintain, replace and dispose of.

The present Australian Federal Government claims that it will make Australia a *"Green Energy Superpower"*, while at the same time actively dismantling what already is – and has long been – a ***real*** 'energy superpower', without having to shout about the fact.

It's how the nation's wealth and prosperity became a reality, and how it is now being squandered.

There is no such beast as a 'green energy superpower' alive on this planet (despite the UK government's identical claims), and there will never be under the present delusional rhetoric.

And, while we might wait in anticipation, we don't hold our collective breath for *"new technology developments"* to become the saviour for a green energy transition – if they ever do.

Gas Turbine Generators

These complex machines offer many advantages, including relatively light-weight construction, relatively quick-starting, can have a quick response to changing grid conditions, and can use a range of liquid or gaseous fuels.

However, they are expensive, generally limited to relatively short duration operations, consume oxygen for combustion just like any other conventional thermal power plant, are very inefficient in basic forms (such as open-cycle sets), and may achieve higher efficiencies in more complex and costly forms (such as combined-cycle sets).

Practical experience indicates that a natural gas turbine exhaust contains methane. **Methane is such a strong greenhouse gas that it often cancels out the benefit of converting out of coal.** The net result does not mitigate climate change, no matter how extensively deployed.

Gas-fuelled power plants are hostage to the availability of fuel supplies at an economical cost. Many are now non-operational as a direct consequence of fuel supply issues and high fuel costs. Gas prices have skyrocketed around the world, especially in the midst of supply shortages and delivery constraints.

Network data shows that gas-fuelled power plants are now rarely used in Australia. This is a sure sign of very expensive back-up power plant going to waste, at great cost to both electricity consumers and taxpayers.

A local example in Australia is a reasonably new 385 MWe Combined Cycle Gas Turbine (CCGT), which has been mothballed for several years because the price of gas has made it more economically viable to sell the gas on the market, rather than using it for power generation.

Hydro Power

A giant 'battery' that stores the potential energy of water, until it is used to drive a water-turbine and generator to produce electricity (a synchronous generator).

While ideal in suitable areas, hydro power is not possible in many regions where available water supplies and large catchment and storage areas do not exist. It is hugely expensive to develop and maintain, involves often vast topographic and habitat harm, and is seriously weakened by a dependence on adequate rainfall and/or snowfall.

Historically, we know that low rainfall and poor snow seasons are painfully frequent (as both New Zealand and Australia have often found), and conflicts can arise between the competing priorities for energy storage or flood mitigation in hydro reservoirs.

A recent example was experienced in Australia, with the panicked release of massive quantities of water from the Wivenhoe Hydro Dam (QLD), and the consequent extensive downstream flooding of farming and residential regions, including large areas of Brisbane City in 2011 and 2012.

The construction costs of hydro power plants are huge, but they do serve a very useful purpose (when available, and with adequate water supplies), and generally have very long operational lives. They are a far better energy storage option than batteries.

Another 'popular' form of hydro, being spruiked by some proponents, concerns "pumped storage hydro". However, historical data shows that these can very easily become unviable, especially when night-time pumping modes are restricted by the already high cost of electricity for pumping operations.

This issue will continue to escalate, unless we return to conventional base load power generation, and to our original and much lower power prices. Pumping would need to be conducted only when wind energy is available at suitable scale, or only during the day (a time when hydro generation is most likely to be needed for grid supply).

"The economic viability of pumped hydro relies on the storage system receiving capacity payments. However, fossil fuel plant owners will oppose being forced to make capacity payments to other parties because pumped storage system use will reduce fossil fuel generation requirements (and profits)." [Dr. Charles Rhodes, ibid].

Biofuels

A *'fashionable'* term for fuels based on vegetation and waste material, such as plantation forests (supplying woodchips), sugar cane mulch, agricultural crops such as sorghum, and green waste or some forms of domestic waste from municipal waste recovery facilities.

There are too many arguments against the use of so-called biofuels, especially in the context of grid-scale power supplies, and many of those arguments centre on the nature of the resultant emissions and waste products (much less than the appropriation of arable land for their fuel supplies, and the consumption of oxygen for combustion).

If you need convincing, just take a look at the adverse circumstances that other nations are experiencing, including Germany, Denmark, the UK and Canada (just to name a few). Then compare these examples to France, as just one example of a nation which doesn't rely on biomass or renewables for power generation.

"Bio-fuel feedstock should be reserved for making jet fuel, for which there is no other substitute. This limited feedstock should not be wasted on electricity production that can be met economically with nuclear power." [Dr. Charles Rhodes, ibid].

But, Is There A Fossil-fuel-free Option?

If we really want to have fossil-fuel-free base load power grids, then we must look to options which do not involve the combustion of conventional fossil fuels of any kind.

That is, if we absolutely must avoid the consumption of massive quantities of oxygen for combustion, and the production of emissions products from combustion, including CO_2, ash and flue dust from coal, and a range of *'horrors'* from biomass waste (other than its exclusive use for jet fuel, as noted above), or Methane – a strong greenhouse gas – from gas-fuelled thermal power plants.

Note that, in the context of this discussion, we are only talking about the combustion of fossil fuels for energy generation, remembering that our daily lives are heavily dependent on the use of fossil fuels as essential ingredients for the production of everything from life-saving medicines to the critical materials used in many products (ranging from prosthetics to construction materials).

[If you're curious, the US Department of Energy lists more than 6000 vital items that are produced using fossil fuels].

The Earth's atmosphere is composed of about 78 per cent (%) Nitrogen, about 21% Oxygen, 0.9% Argon, and about 0.1% comprises of all the other known gases.

These *"trace gases",* as they are known, include *"trace"* amounts of Carbon Dioxide (CO_2) at 0.042 per cent, followed by Neon (Ne), Helium (He), and Methane (Me), and so on. *[National Oceanic and Atmospheric Administration, https://www.noaa.gov/jetstream/atmosphere, last updated July 2024].*

Water vapour makes up about 70-80% of our atmosphere (although the fraction varies enormously with position, temperature and altitude), with about 25% visible as clouds, and plays a significant role in Earth’s natural greenhouse effect. *[https://theconversation.com, adapted from Trenberth (2022), CC BY-SA].*

How can we consider that Carbon, in the form of Carbon Dioxide (CO_2), is a pollutant? After all, it is an essential plant food (feeding our fauna on both land and in the sea), to support the process of photosynthesis and the production of plant sugars and Oxygen, which is essential for our existence.

Many scientists believe that what matters most, and is of greatest concern, is where CO_2 exists in our atmosphere and what effect it has on our lives. An extensive body of research, ranging from the early 70's up to the present time, reveals that atmospheric CO_2 effectively acts as a thermal blanket, higher in Earth's atmosphere.

"This effect not only keeps us warm, but also reduces the degree of radiation which is being reflected back into space, which in-turn causes net planetary heating beyond that directly caused by atmospheric CO_2.

"The issue cannot be resolved without reducing the production of CO_2." *[Dr. Charles Rhodes, in "Infrared Emission" and "Albedo", Published by Xylene Power Ltd (xylenepower.com), ca. 2020]*.

But, we shouldn't forget that practical experience indicates that a natural gas turbine exhaust contains methane, and that **methane is such a strong greenhouse gas that it often cancels out the benefit of converting out of coal**. The net result does not mitigate climate change, no matter how extensively they are deployed.

We examine and discuss relevant aspects of the climate debate in Part 3 of our series of background studies.

Of a lesser magnitude, Carbon Monoxide (CO), definitely is an enemy, and must also be avoided. CO is a function of poor combustion, which is a major factor in most of the developing nations (especially certain Nation States which have huge populations and massively developed heavy industry (including power generation).

While poor combustion can occur in any situation where fuel combustion is incomplete – from power stations, to transport vehicles, to home heating and cooking – we can be very confident that CO is not a factor in modern, developed civilisations where properly managed and maintained high-efficiency and low-emissions power stations have been operating for decades, alongside efficient and well-serviced petrol-engine vehicles.

Remembering that petrol, just like coal, has a relatively high energy content (unlike most other fossil fuel types), there is only one other fuel which offers a considerable energy advantage, something ranging in magnitudes far greater than any fossil fuel...

Nuclear Energy

Energy-dense Nuclear energy is the only viable alternative for synchronous base load power generation and, if we are going in this direction, then we need to be well-informed with regard to the various forms of available and proven nuclear power generation technologies.

"There are significant differences between the various types of nuclear power generation, particularly with regard to relative efficiencies, and these aspects should not be ignored." *[Dr. Charles Rhodes, in advice to the authors, on 12 July 2024].*

Clearly, decisions regarding robust legislation and the selection of one type of nuclear power plant over another, must be guided by credible, expert and suitably experienced specialists. Dr Rhodes warns:

"A major issue is public education with respect to nuclear power. We can anticipate misinformation from both the fossil fuel industry and from most nuclear reactor suppliers (because of bias in favour of proprietary products)."

And notes that: *"An exception is the **Natrium Reactor** from Terra Power which is a sodium-cooled fast neutron reactor. (Bill Gates is a principal investor in this technology).*

"The blunt reality is that the most fuel-efficient large power reactor presently available is the CANDU (CANada Deuterium Uranium), a well-known large Canadian reactor type.

"It is also the most efficient for TRU (Tritium) production, a byproduct which can be used to fuel fast neutron reactors in what effectively is a complementary waste recycling process, which will become important as the price of natural Uranium rises due to depletion of the natural resource.

"Canada adopted the CANDU reactors in the 1960's, to avoid dependence on other countries for the supply of enriched fuel... However, CANDU reactors require heavy water, which Australia would have to either make or import. It would be helpful for Australian decision-makers to visit the reactors at Bruce, Darlington and Pickering in Ontario.

"However, at some point Australia must make a commitment to Australian engineering education. Ontario Power Generation and Bruce Power both have educational videos which are worth careful study." [Dr. Charles Rhodes, 26 July 2024].

We examine and discuss relevant aspects of Nuclear Energy in Part 4 of our series of background studies.

Informed Commentary

Sadly, and in many Western countries (including Australia), misleading and often false and even vile claims about nuclear energy have tarnished its image in the public view, and this poorly informed position must change.

Thankfully, there are some leading lights standing up to be counted, in favour of an energy transition to nuclear power generation. One in particular, a young Australian, is standing tall and strong against incredible and often unreasonable and unacceptable odds.

Anyone who wants a balanced and well-reasoned view on the subject of nuclear energy (and we should all want that), is urged to explore the adventures of young ***Will Shackel*** via his website "*Nuclear for Australia"*. *[https://www.nuclearforaustralia.com/about].*

Video recordings of some of Will's television appearances are highly recommended viewing, especially to observe how he effectively and calmly deals with misinformation in a calm, strong, well-informed and reasoned manner. And the website offers a number of very helpful fact sheets explaining relevant aspects of nuclear energy.

To those of us who have been around for a while, he is a breath of fresh air, and we have hope that he will also be a refreshing and reassuring model for his own generation, in particular, and also the generations that succeed him.

The following links are highly recommended viewing:

Q+A | Nuclear Waste https://www.youtube.com/watch?v=naR0xFk2_dw

Q+A | Nuclear Ban https://www.youtube.com/watch?v=jBcSugoYtVg

Q+A: Should Australia Go Nuclear? https://www.youtube.com/watch?v=mlq_7ouIoqM

Undermining trust in nuclear science: Will Shackel https://www.youtube.com/watch?v=eFJFntwMDjU

Australia's present hypocrisy in the form of a ban on nuclear energy in this country must be reversed, as a matter of utmost urgency, so that we can then start down the hard road of realising a nuclear-sustained base load power supply in the near future.

We note that the Australian Nuclear Science and Technology Organisation (ANSTO), with a small nuclear reactor based at Lucas Heights on the southern outskirts of Sydney, proudly claims over 60 years of experience in nuclear science and technology.

Australia has engaged first-hand with nuclear energy for research and medical purposes over many decades, despite the claimed ban, yet many politicians and activists choose not to acknowledge this fact.

Along with most of its other natural resources, Australia also exports Uranium for nuclear power generation. But, and for no valid reason, we cannot use it to assure our own energy security. This blind stupidity must change.

We will need it, soon, because renewables are never going to be the answer. If we had started down this road 10 or 20 years ago, we wouldn't be confronted with this problem today. We really don't want to be saying the same thing in another 10 or 20 years.

We examine and discuss relevant aspects of Nuclear Energy in Part 4 of our series of background studies.

Another highly respected researcher and commentator, ***Dr. Bjorn Lomborg*** of the Copenhagen Consensus, in his recent Newsletter (published 20 July 2024), reported the following insight: *"The Green Energy Transition That Wasn't"*, noting that:

"Even as governments throughout the rich world push heavily subsidised renewables, fossil-fuel use continues to increase. We need to face the fact that the much-hyped 'green energy transition' is not actually happening.

"Countless studies show that, when societies add more renewable energy, most of it never replaces coal, gas or oil. It simply adds to energy consumption. On this trajectory, we will never achieve an energy transition away from fossil fuels."

Mr Lomborg points out that governments are *"really asking voters to support throwing more good money after bad. We need a smarter approach."* *[ea@lomborg.com].*

He has published a number of books and research papers which clearly identify how our money is being wasted, and precisely where and how that money would be better spent.

But, are governments listening? It seems that institutions such as the United Nations, World Health Organisation, World Bank, our own government and others, certainly are not.

Only a handful of commentators in the Australian media have covered these topics in a credible, balanced and well-informed manner, and ***Chris Kenny***, Associate Editor with The Australian, and host of *"The Kenny Report"* on Sky News is perhaps top of the tree. His series of articles on this topic are well-researched and highly informative, and expertly supported with those of Chris Uhlmann, Graham Lloyd and Peta Credlin, in particular, and others.

Now to consider some critical aspects of a synchronous base load electricity grid which are rarely mentioned...

Grid Restart and Unit Islanding

Most importantly, and when it comes to a grid-restart (or a "black-start", as it is also known), following a total loss of the network (when it is completely de-energised, or "*black*"): ***"Only a large synchronous AC generator will be capable of undertaking the task."*** *[Dr. Charles Rhodes, ibid].*

This is a complex and challenging operation, and one which is difficult to accomplish. Fortunately, and until now, it was a rare situation, but this also means that few power plant or system operators have the opportunity to practice the procedure in '*live*' exercises.

Despite several decades closely associated with the use of high-fidelity, replica power plant simulators, we have not yet experienced a credible replication of a large, grid-scale electrical system. Most importantly, we await the opportunity to experience a *'simulation'* of grid-scale inertia.

Re-energisation of HV electrical circuits is always a stressful situation, and the utmost care and attention, underpinned by careful and detailed planning, must always be exercised. The levels of tight collaboration and co-ordination between the key parties are vital and intense.

It is common for several attempts to be made before a successful restart is achieved, and it is not uncommon for this exercise to take several days in some regions. Having the right power plant is one thing, but also having the right HV electrical system set-up for the islanded power plant, are also critical factors.

More often than not, failure is not necessarily an issue with the power plant itself, but it rests with a particular characteristic of the islanded electrical system (such as "*capacitance*", for instance). It is always very challenging to work with something which is invisible, powerful and exceptionally dangerous.

Some jurisdictions have had the foresight to install large base load power plants which have a "***Unit Islanding***" capability. In the event of a major grid fault, the selected generating unit/s will be instantaneously separated from the grid ("*Islanded*"), to prevent them being shut down as a consequence of the grid fault.

In these circumstances, the islanded generating unit/s use a combination of high pressure and low pressure *Steam Bypass Systems* to rapidly reduce output to a level which is self-sustaining (known as the "*House Load*"), and will remain operating until cleared to reconnect to the grid in a carefully managed process (islanded sections of the grid, each energised in sequence – not all at once).

A high priority for this operation is the re-energisation of networks linking other base load power plants, thus enabling their early restart. This is an effective contingency which may avoid the "*Black Start*" issues noted above, provided that the plant is effectively maintained and managed by properly trained operators and technicians. Sadly, and in many jurisdictions, this is often not the case, and numerous examples of the consequences can readily be identified.

"Even where detailed procedures have been developed to support grid restarts, significant personnel changes and the growth of a power system over 20 years may mean that procedures are no longer accurate or even adequate for the system as it is today."

And the growth of renewable inputs also greatly increases the complexity and potential risks associated with the re-energisation process. *"There is no easy or simple answer for this dilemma, but essential contingency planning must consider that a black start is not a task for amateurs, and that even experienced personnel can easily make serious mistakes.*

"A problem that repeatedly arises is that equipment which is essential for rapid black start is accidentally taken out of service, or actually removed from service, before a system shutdown occurs. It is vitally important to periodically check that all of the equipment required to support a black start actually exists and is fully functional.

"This is a very real issue if, for instance, a natural gas fuelled turbine relies on upstream electricity to raise the natural gas pressure and temperature sufficient to run the turbine. Enabling the required fuel switching is often not automatic, and may require a site visit by a suitably qualified person.

"Mistakes can lead to equipment explosions. This problem is compounded if the black start was triggered by severe weather that makes travelling dangerous, or there are issues accessing the site, and by communications issues." *[Dr. Charles Rhodes, ibid].*

Energy Security and Energy Poverty

Finally, let's be clear in our understanding of two expressions which feature strongly in the media:

Energy Security is defined as the ready availability of essential energy services at an acceptable frequency and risk of interruption and at an acceptable economic cost.

[The old terms would have been "maintain continuity of supply", and "at the lowest possible cost". Standards have clearly slipped.]

Energy Poverty can be defined as a lack of energy access... or, for example, a household spending a high percentage of its income on energy bills, or reducing its energy consumption to a degree that negatively affects its health and well-being *[minimising or missing meals, and foregoing medical services, for instance]*.

[Both definitions were sourced from the International Energy Agency (iea.org), on 14 July 2024].

What do the conditions, "*an acceptable level of risk of interruption*", and "*an acceptable economic cost*" mean to you, or to your neighbours, or the homeless families you've recently observed camping in the local park?

Are these parameters based on a realistic assessment of what the retail consumer can reasonably afford, or is it based on the whims of unelected and ideologically-driven international organisations and weak governments.

What impact are rising electricity tariffs (and falling feed-in tariffs, if you can afford to have rooftop solar), having on your family budget?

How many people in your community are foregoing household heating and cooling, simply because they cannot afford to use their heaters or air conditioners/heat pumps? Dr Charles Rhodes notes:

"An issue that Australia must face is that it is very expensive to have large redundant fossil fuel generators which are only occasionally used when wind and solar energy all fail. Once available hydro generation is fully utilised, there is no practical alternative to base load nuclear power generation.

"Nuclear is cheaper than wind plus solar plus energy storage plus 100% fossil fuel backup. That fossil fuel backup must be composed of large synchronous generators to enable grid restart.

"Distributed generation is a more expensive transmission and distribution network and the network costs of supporting bi-directional power flow are huge.

"Only a synchronous generator with a large rotating mass can easily absorb a large amount of power. Providing that capability via power inverters and electrical energy storage is extremely expensive." [Dr. Charles Rhodes, 10 July 2024].

It should be noted that both Energy Security and Energy Poverty are only political issues in Australia. However, and in other countries (such as Canada, for instance), they are lifesaving and life preserving issues where the entire country, from governments to communities, must do all in their power to ensure that no person is left out in the cold in any mid-winter period.

Some Basic Arithmetic

In Australia, tax payers and consumers have never been provided with a credible answer to the question: *"Why have our electricity costs been rising so much, and why will they continue to rise?"*

We are also regaled with the claim that renewables are the cheapest and cleanest energy source, and that justifies this *"essential"* investment (at an unknown cost).

Dr Charles Rhodes offers the following short summary to illustrate a number of important facts about the costs associated with the introduction of renewable generation to our electricity supply (in the Australian context):

Assume an electricity grid fed by 12 x 100 MWe of synchronous power generation;

The peak daily load = 10 x 100 MWe Minimum daily load = 600 MWe.

Thus, at any time, one 100 MWe synchronous generator can be off-line for scheduled maintenance, and the System can still tolerate a second 100 MWe generator or transmission failure due to an unplanned fault.

The average daily generation = 800 MWe x 24 hrs = 19,200 MWe-h

Therefore, and in normal operation:

Consider that each steam turbine also comprises of one steam boiler (the steam generator), together known as a "generating unit";

Maximum fractional load on the generating units is: 1000 MWe / 1200 MWe = 0.833 = 83.3%

Minimum fractional load on the generating units = 600 MWe / 1200 MWe = 0.500 = 50%

Normal Spinning reserve = 100 MWe / 1200 MWe = .0833 = 8.33%

Best case spinning reserve = 200 MWe / 1200 MWe = 16.66%

Now suppose that uncontrolled renewable generation is connected to this same grid:

Assume that renewable generation has a capacity factor of about 0.33

Peak permitted renewable generation capacity = 600 MWe

This peak renewable capacity is only available provided that synchronous generators continue to operate at zero power to act as frequency stabilizing synchronous condensers.

The average renewable generation output is: 0.33 X 600 MWe = 200 MWe.

The maximum fraction of grid energy supplied by renewables is: 200 MWe / 800 MWe = 0.25 = 25%.

While renewables are connected to the grid, the average generating unit load is: 800 MWe – 200 MWe = 600 MWe

The average fractional steam generating unit load is: 600 MWe / 1200 MWe = 0.500 = 50.0%.

A fundamental problem is that connecting the renewables has moved the average generating unit operating point from 66.6% down to 50%.

When a synchronous generating unit has to unload, oil support for the safe combustion of fossil fuels is generally required for many types of boilers (especially during a coal pulveriser changeover, for instance). This cost also needs to be accounted for.

To summarise this data, the result of connecting the intermittent asynchronous generation to the existing grid:

a) Saves nothing in synchronous generation capital costs;
b) Causes additional capital costs for renewable generation and transmission equipment;
c) Retains synchronous generation maintenance costs;
d) Reduces synchronous generation fuel costs by (16.6 / 50) = 33.2% (plus any oil support costs);
e) Causes additional fuel costs for synchronous generation by moving steam generating units from an average load of 66.6% down to an average load of 50%. Steam generating units become progressively less efficient at low fractional loads, and oil support for combustion safety is critical.
f) Causes additional operating and maintenance costs associated with renewable generation.

As more intermittent asynchronous renewable energy generation is added to the grid, it becomes necessary to control the load to take full advantage of the intermittently available clean power. Otherwise a lot of money is spent with little net CO_2 emissions reduction.

Almost all the synchronous generation costs are retained, and all the renewable generation costs are additional. Moreover, the value per kWh of the renewable generation is less than the value per kWh for the synchronous generation. **Parties who claim that renewable asynchronous generation is less expensive than synchronous generation simply do not know what they are talking about.**

The correct way of costing an electricity system is to look at it from the perspective of the retail consumer. Instead, today we have governments and their minions that are focussed on appeasing the demands of unelected international bodies, and the cost to retail consumers is largely ignored.

With reasonable placement of the power plants the costs of transmission, distribution, energy storage, black start, spinning reserve, and etc, are all minimised. The cost of amortisation is also minimised.

Moreover, and **in the case of nuclear energy, the fraction of fossil fuel displaced is almost 100%**, compared to about 50% in Australia's present plan.

The Key Points

Clearly, the realities are that:

1. In the first instance, ***synchronous generators*** **are absolutely critical to a fully functioning base load power system**. They, alone, establish and sustain the frequency of the grid. It is the massive ***inertia*** of these machines which stabilises the network in a normally operating system;

2. Conversely, *asynchronous* and intermittent renewable energy generators (and other electrical control devices), have little to no physical rotational inertia. Accordingly, **asynchronous generators cannot control frequency or any other forms of system instability** (voltage, current, load, reactive power and etc);

3. In the absence of a healthy base load AC power system, household asynchronous generators – solar PV panels, wind turbines or wave generators – will not generate electrical energy (without also having an integral battery, and a network isolator);

4. Further, and if intermittent asynchronous generators are the largest component of a power system, then the system will be functionally unstable and uncontrollable.

   A base load AC power system becomes progressively more unstable as the ratio of intermittent asynchronous generation to synchronous generation increases.

   In other words: **There cannot be a functioning base load system which is solely or mainly comprised of intermittent asynchronous power generation sources.** It will simply not be a base load system;

5. Accordingly, **a secure base load grid should obtain no more than 20% of its energy from intermittent asynchronous energy generation**, *"noting that intermittent generation typically has a capacity factor of about 33%.*

   "Hence, intermittent generation that on average supplies 20% of the system energy might meet as much as 60% of the system demand at a time when the wind is strong and the sun is shining. However, and under those circumstances, the fraction of synchronous generation may not be sufficient to maintain grid stability;" [Dr. Charles Rhodes].

   Despite the fact that it only has 75% of renewable energy capacity (according to its own records), the Government of South Australia recently boasted that almost 100% of the State's demand was met with renewables. But, there is at least one inconvenient and unstated truth:

   What was **not** noted was the important fact that the stability of their electrical system would only have been possible due to the State's grid connection to the much larger East Coast Grid (which comprises of several very large coal-fired, gas-fired and hydro synchronous generators);

6. Intermittent asynchronous power generation must not be connected to remote 'one-way' power distribution networks, as these networks are not set up for the 'reverse flow' of electrical energy (and the cost of adapting them with suitable protection, metering, control and switching equipment is huge);

7. In present circumstances, **there is no rational justification for the replacement of existing synchronous AC generators with intermittent asynchronous power generators** (at least until sufficient new base load synchronous generators are available to replace the existing generators, and to balance any proposed new renewable energy generators);

8. **The addition of intermittent asynchronous renewable energy generation to the electricity grid simply adds new and greater costs and risks to the electricity supply system – it will never be cheaper or more efficient.** Without capacity billing, asynchronous behind-the-meter generation (such as household systems), has the effect of transferring electricity system costs on to other electricity system customers;

9. The **only viable alternative to conventional fossil fuel base load AC power generation** is to install carefully selected nuclear power plants, noting that while Small Modular Reactors (SMR's), are a popular topic at this time, they are not necessarily the best choice, and nor are some of the other conventional nuclear plants.

   Countries like Australia, with extensive electricity systems, will be far better served if they invest in suitable advanced nuclear technologies which enable fuel reprocessing, which in-turn assure a sustainable fuel supply.

   Governments need to consult widely, and with recognised independent experts in the field, especially because a major issue in reactor type selection concerns the future availability and cost of nuclear fuel;

10. *"Present government-led climate change mitigation policies are not founded in physics and are ineffective.* ***Instead, we mostly need sustainable nuclear power, synchronous generation and capacity-based electricity billing****.*

    "When these things are in place, the electricity grid system will be able to accommodate ***about 20%*** *energy contribution by wind and solar generation.*

    "A larger fraction of wind and solar generation is only economically viable if the geography of a nation supports large amounts of hydraulic energy storage." [Dr. Charles Rhodes, 'Nuclear Mitigation of Climate Change', September 2024].

However, and when we consider a country like New Zealand, which has an extensive hydro power generation network and boasts of a rapidly expanding intermittent asynchronous renewables network, the country's energy grid must be daily bolstered by one large coal fired power plant.

This dependable synchronous power plant is supplied with low-quality and high-emissions coal imported from Indonesia, despite the fact that NZ itself has extensive reserves of high-quality and low-emissions coal resources!

To what extent does this factor reduce the claimed benefits derived from their unreliable intermittent asynchronous and costly renewables network investment?

11. **A grid system should include large base load generators which also have *Unit Islanding* capabilities**, in order to minimise the risk of *'black start'* situations.

    "*Following a total loss of the network (when it is completely de-energised, or "black"), "**only a large synchronous AC generator will be capable of undertaking the task**."* *[Dr. Charles Rhodes].*

12. **We absolutely need to retain and maintain our existing large base load power plants** – and especially those that also have *'Unit Islanding'* and '*Black Start'* capabilities – until new and at least equivalent capability replacement base load generators have been commissioned;

13. Power dispatch protocols must urgently be revised in favour of synchronous base load generators, in order to **assure *Energy Security*** and to **avoid *Energy Poverty***, and to encourage investment in the provision of essential base load power generation and other network services;

14. *"The value of electricity is based on both 'reliable capacity' and 'energy'. Therefore, **'kW capacity' and peak demand pricing (in addition to kWh pricing), must form the basis of overall network pricing".*** *[Dr. Charles Rhodes]*;

15. **Nuclear energy is the only viable alternative base load fuel source** which will not add further CO_2 to our atmosphere;

16. Together with CANDU reactors, fast nuclear reactor (FNR) technology with supporting fuel reprocessing is **the only route to sustainable clean power for fossil fuel displacement**;

17. **It is essential that urgent progress is made to replace present fossil-fuel based synchronous generating capacity with suitable nuclear powered synchronous generation options**;

18. *"An issue that Australia must face is that it is very expensive to have large redundant fossil fuel generators which are only occasionally used when wind and solar energy fail. Once available hydro generation is fully utilised for energy storage, **there is no practical alternative to base load nuclear power generation**.*

    *"Nuclear, alone, is cheaper than wind + solar + energy storage + 100% fossil fuel backup. That fossil fuel backup must be composed of large synchronous generators to enable grid restarts, and to provide ongoing **grid transient suppression stability**.*

    *"**Distributed generation for renewable energy generators is a more expensive transmission and distribution network**, and the network costs of supporting bi-directional power flow, and matching synchronous capacitors and energy storage, are huge.*

    *"**Only a synchronous generator with a large rotating moment of inertia can easily suppress large power surges**. Providing comparable surge suppression capability via power inverters and electrical energy storage is extremely expensive, and is not presently found in most systems."* *[Dr. Charles Rhodes].*

19. With the benefit of a mathematical analysis based on the Australian context, Dr Rhodes summarised the likely result of connecting intermittent asynchronous generation to the existing grid. He explained that doing so:

    a) Saves nothing in synchronous generation capital costs;

    b) Causes additional capital costs for renewable generation and transmission equipment;

    c) Retains synchronous generation maintenance costs;

    d) Adds additional operating and maintenance costs associated with renewable generation;

    e) May reduce synchronous generation fuel costs by about one-third, provided that oil support is not required to maintain safe combustion conditions, and that steam turbines are designed for high efficiency at part load [which is uncommon with large base load power plants]; and

    f) Causes additional fuel costs for synchronous generation when the output of steam generating units is reduced from their normal operating load down to a lower average load. Steam generating units become progressively less efficient at low fractional loads, and oil support for combustion safety is critical.

    Dr Rhodes concludes that:

*"As additional intermittent asynchronous renewable energy generation is added to the grid, it becomes necessary to control the load to take full advantage of the intermittently available clean power, **otherwise a lot of money is spent with little net CO_2 emissions reduction**.*

"Almost all the synchronous generation costs are retained, and all the renewable generation costs are additional.

"Moreover, the value per kWh of the intermittent renewable generation is much less than the value per kWh for the dependable synchronous generation.

"Parties who claim that renewable asynchronous generation is less expensive than synchronous generation simply do not know what they are talking about.

"Intermittent generation only makes financial sense for process loads that are not time sensitive, and that the electricity utility can control (such as for battery charging, electrolytic Hydrogen production and electrolytic metallic Sodium production)." [Dr. Charles Rhodes].

20. **Biomass should be reserved solely for the production of aviation fuel as, at this time, there is no other viable non-fossil alternative**;
21. Rapid adaptation is a strategy which we all must consider, and can act on, now. But **we will absolutely need a dependable synchronous base load electricity supply** to support any efforts to take a meaningful and proactive approach to developing a state of resilience; and
22. **The cost of base load energy is embedded in every other product and service that we procure**. **We simply cannot afford the full cost of 'renewables'**.

    We need base load energy sources that can be amortised over 100 years, not 20 years. We cannot afford to multiply the electricity transmission and distribution systems several times to enable use of low capacity factor generation. Even centralised energy storage adds considerably to the overall electricity cost due to much greater electricity transmission requirements.

What Must Be Front-of-Mind

Our conclusions can only be that **it is vital to maintain a strong base load power system – one that is essentially comprised of large synchronous AC generators** for both supply to and control of the grid, and which are capable of generating reliably and efficiently 24 hrs/day x 365 days/year, over many years.

Further, this foundation must be prioritised (*'preferenced'),* by Governments and the National Energy Market Operator (AEMO), to the appropriate exclusion of intermittent renewable energy sources.

This is the only way to maintain *Energy Security* and to allow for the properly managed introduction of intermittent asynchronous generators.

Importantly, **the addition of any new intermittent renewable generation must always be conditional on grid capacity** (maintaining the inherent strength and resilience of the grid network).

Remember, too, that **it is the large base load generators that provide the cheapest and most reliable base load power generation**, and they will do so over a lifetime which far exceeds that of any intermittent renewable power generators. But, this is only possible when they're not deliberately priced out of the market by unrealistic and unaffordable subsidies for renewables;

***'Dependable Capacity'* pricing is required.** The dependable capacity value of most wind and solar generation is zero.

It can only be considered foolish in the extreme to procure the removal of existing base load AC generators, and their replacement with intermittent asynchronous renewable energy generators.

Any form of cost-benefit analysis between competing technologies must be soundly based on a full life-cycle analysis which includes any actual or anticipated government (taxpayer-funded) subsidies, and which also accounts for the benefit of reducing CO_2 emissions.

And we shouldn't forget that practical experience indicates that a natural gas turbine exhaust contains methane. and that **methane is such a strong greenhouse gas that it often cancels out the benefit of converting out of coal**. The net result does not mitigate climate change, no matter how extensively they are deployed.

Note that, as intermittent renewable generation increases, the CO_2 emissions reduction per KWh generated decreases, due to the decreasing part-load efficiency of parallel-connected synchronous fossil fuel generation. The costs must also properly **consider the frequent replacement of renewable energy sources**, as against the much longer operational lives of conventional and especially nuclear power plants (around 80 years).

But, looking at what deluded activists and politicians are driving for today, **we should certainly be prepared for blackouts and worse**, before realisation of the facts and of the consequences becomes a reality for all of us. And who pays the price of these delusions?

Even the recent Chief Scientist for Australia, *Dr Alan Finkel*, admitted that **there would be no benefit from the country's head-on drive to "Net Zero Carbon" by adopting renewable energy at any cost!** Why would this view be any different for other nations?

Worse still, we don't know what that cost is actually going to be, as governments avoid the question (for obvious reasons). **We only know that the cost of energy storage and network stabilisation to support renewables will be huge**. Is this the burden that we should leave for our children?

The Bottom line is that **the health, wellbeing and wealth of a nation's economy and its people are absolutely dependent on the provision of a plentiful, economical, affordable and reliable supply of synchronous base load electrical energy**.

Every nation needs a strategy that costs less, that achieves real climate change mitigation, that is much more reliable and much less intrusive to property owners. Nuclear power can also provide industrial heat, efficiently and economically. Where temperatures greater than 500 degrees C are required, a gas cooled reactor or a molten salt reactor can be used.

Importantly, **this extends to the ability to assure our resilience and survival**, not just for enabling us to effectively mitigate the effects of climate change, but especially to secure our resilience in the event of trade sanctions or war. This is a fact that cannot be disputed, and there is no other ready-made alternative to the facts as we know them.

It is also clear that we desperately need to **assure our future by replacing present fossil-fuel power generation with nuclear power as the only viable clean energy source**, and that progress towards the total replacement of our use of fossil fuels for power generation must be our greatest focus.

Plutonium-based fissile fuel is key to sustainable nuclear power. But, we must be alert to resistance from Uranium-based competitors.

To meet the CO_2 emission constraints there is no practical alternative to sustainable nuclear power. Nuclear power plants need to be designed for the longest possible working life, and located such that the rejected heat can be used for further fossil fuel displacement (such as the conversion of Agri waste into jet fuel, for instance).

Retail electricity prices need to be set to as much as possible flat load the nuclear plants (at or near to their MCR). Electricity prices need to be set mainly by peak demand rather than energy consumption charges. In that market the value of intermittent wind and solar generation is very low.

It is also clear that we desperately need to **assure our future by replacing present fossil-fuel power generation with nuclear power as the only viable clean energy source**, and that progress towards the total replacement of our use of fossil fuels for power generation must be our greatest focus.

It is critical that basic AC power concepts, climate concepts and nuclear power concepts all become core curriculum subjects in our schools.

We are at a crossroads, a tipping point which has civilisation-wide impacts. It's your call, so please make it the right call, on behalf of all people in particular, and civilisation in general.

The cost of base load energy is embedded in every product and service that we procure. We simply cannot afford the full cost of renewables. We need base load energy sources that can be amortised over 100 years, not just 20 years.

We cannot afford to multiply the electricity transmission and distribution systems several times to enable use of low capacity factor generation. Even centralised energy storage adds considerably to the overall electricity cost due to much greater electricity transmission requirements.

Why do we need to be paying far more for renewable energy that, in a properly priced and resourced electricity grid, is clearly unnecessary? If retail-focussed pricing is restored, and nuclear energy supply replaces all fossil fuel sources, we will not need anything else.

Energy poverty cannot be allowed to eventuate or prevail for purely ideological purposes, in any World. Energy Poverty isn't coming, it's already here!
Do we really want Energy Insecurity as well?

The Big Issues!

Dr Charles Rhodes warns that *'The Big Issues'* that must be addressed concern **the long-term supply of clean nuclear fuel**, and that there is only one sustainable path (which we examine in Part 4 of this series).

Another is that: *"Until a sufficient fraction of voters understand the issues, it does not appear possible for a near-term solution to be realised."* And to be aware that:

"The fossil fuel industry has shown that it will do everything in its power to stop deployment of the advanced forms of nuclear reactors. In previous years, we have witnessed the actions of the tobacco industry. Today, the problem is the fossil fuel industry, and we cannot afford to underestimate their power." *[Dr. Charles Rhodes, ibid].*

We also know that, since at least 2001, ministers and ministerial advisers in the UK Government have served in decision-making roles while clearly having conflicts of interest through direct paid engagements with renewable energy sector companies, or have published misleading and incorrect information to justify their 'Zero Carbon' policies and expenditures. Refer in particular to information regularly published by the Net Zero Watch UK group.

Clearly, it is imperative for all of us to <u>not</u> be alarmed, but to be alert, informed and decisive.

Epilogue

The sun is now streaming into the room, warm and welcoming, despite the lack of electricity. You put down the magazine that you started reading in the crisp early morning light.

You have just finished reading the story about a boy who lived through an earlier time, in a different world on the other side of the planet. Now a well-informed and highly qualified senior member of his community, he relates a story which stands in stark contrast to your own.

The story opens with a photograph that appears to be of a child, suitably protected – almost concealed – from the elements by an abundance of thick weather proof clothing, and standing at the front door of a house, amidst large mounds of white snow.

Unlike the land that you enjoy living in, with its comparably mild and pleasantly warm winters – with not even a hint of snow in your neighbourhood – the main character of the magazine article tells a very different story.

The boy explains that winter temperatures in his region can routinely reach minus-40 degrees Celsius, so the lives of his family and community have a very different perspective about electricity supply.

In the 1950's, every home was prepared for the sustained loss of AC power. His home originally had two fireplaces, three wood and/or refuse-burning stoves, and a naturally circulated coal-fired central hot water heating system, all of which would work without electricity.

There were also calcium carbide lamps in place of flashlights, and kerosene lamps for the dining room and kitchen. The house was serviced with gravity-fed fresh water, and good gravity-enhanced drainage.

Just like his school friends, the boy also did his best to help his parents with the summer chores of gathering, cutting, chopping and storing wood for fuel, carrying buckets of coal into storage in the basement of their home.

In winter, he helped with the daily chores of collecting and disposing of ash from the burners, and restocking wood and coal close to the respective burners in the house, and refilling carbide and kerosene lamps. It was not just a matter of comfort for the family, it was also a critical matter of survival.

He recalled that it was not until the 1960's that the local electricity service became sufficiently reliable, which enabled new housing to be built without the capacity to burn coal and/or wood in a power failure, and they became dependent on pumped services for fresh water, sewerage and drainage.

Since that time, the certainty of a dependable electricity supply necessarily became an essential service in the eyes of everyone, from members of the community to politicians, architects and engineers – essentially assuring the preservation of life across whole communities.

You realise that the advocates of unreliable power are really talking about driving us back 75 years. Do they really understand and appreciate the consequences of that desire, especially on the design and location of buildings, much less than on the provision of essential services?

Since the 1940's, the design and construction of buildings has evolved considerably, and is primarily based on the assumption of a reliable electricity supply – at all times. Think about everything from elevators to emergency lighting in otherwise darkened fire escape stairwells.

Do they understand that large buildings without electric pumps for hot water recirculation must rely on steam and that, for safety reasons, steam systems require 24/7 attendance by licensed steam engineers?

Do they realise that many existing buildings would become unusable for lack of electric pumping capacity to deliver fresh water, and to recover and assure the disposal of sewerage and drainage?

Do they realise that many high-rise apartment buildings don't have opening windows on the upper levels. How will residents endure heat or cold when electric ventilation and air conditioning systems are not available?

Do they realise that elevators and electric locking systems in buildings, including underground parking security gates, will not be functioning in the event of a power outage?

Do they understand that industrial and commercial cold storage systems in transport hubs and supermarkets will not function without electricity?

Do they know how long hospitals and other essential services will continue to function without mains electricity?

Looking at the politicians, and their advisors and bureaucrats who presently dictate how our electricity systems are built: Are they highly qualified electrical and network engineers who know how to design, operate and manage extensive electrical networks, including the realistic setting of prices and planning for future growth?

If a politician needed complex heart surgery, would they expect to have the best possible surgical team looking after them, or would they be happy with anyone who has a First Aid certificate?

Are you prepared for a life-changing regression, back to the dark ages? Are we all now facing "the winter of our own discontent"? Will you allow this to become your future, our future? Will you demand well-informed change?

Access Our Papers

Part 1: A Brief Overview – What We Should Know

Part 2: Our Essential Electricity System (this paper)

Part 3: Aspects of the Climate Debate

Part 4: The Vital Role of Nuclear Energy

View published versions at
https://australianfutureenergyinitiative.substack.com/?r=4q14pd&utm_campaign=pub&utm_medium=web

To request a copy, send your details (full name, post code, and email address – with utmost privacy assured), to *realenergystory@yahoo.com* (copy and paste the address into your new email);

or visit the website australianelectricity.info (use the following address in your internet browser) https://www.xylenepower.com/ Australian%20Electricity%20System.htm, to obtain this discussion paper.

And remember...

Adaptation is a strategy which we all must consider, and can act on, now. But we will absolutely need a reliable electricity supply to support any efforts to take a meaningful and proactive approach.

The Authors

Graeme Jorgensen, Malcolm Keeley** and **Ron Fraley have been actively engaged in power plant commissioning and operations, technical documentation and training/educational roles (including the use of high-fidelity replica power plant simulators), over a period of many years – since the early years in the 70's when the control and management of power plants were largely human activities (both mental and manual). Apart from a range of power plant qualifications (including steam power plant), we have also held electrical, HV switchyard operations and authorised HV switching officer qualifications.

In the early period of our careers, the need to sustain reliable and dependable base load power supplies to growing communities and industries was a responsibility which soon became a badge of honour. We fervently hope this commitment will be maintained into the future, not just by operators and engineers, but most emphatically by corporations and governments.

Graeme, who's electricity industry career spans New Zealand and Australia, was also the founder and Managing Director of a power generation services company, Energen Pty Ltd, which delivered contract commissioning, operating and advanced training services to the sector (across Australia and SE Asia). Together with his close colleagues, Ron and Mal, a highly successful business was developed and operated across 23 years, until Graeme's recent retirement and closure of the business.

Expert reviewer, advisor and contributor, Dr. Charles Rhodes P.Eng., B.Sc., M.A.Sc., Ph.D., is the Chief Engineer of Xylene Power Ltd. and FNR Power Ltd. (formerly known as Micro Fusion International Ltd.). Dr. Rhodes has more than 50 years of physics and engineering experience that includes the development, manufacture, installation, operation and maintenance of distributed energy control and mechanical equipment monitoring systems for major buildings, thermal energy storage systems, pipelines, high efficiency boilers and grid-connected behind-the-meter electricity generation systems.

Dr. Rhodes has been an intervenor and expert witness in Ontario Energy Board (OEB) electricity rate hearings. He has also been an expert witness in Alberta Energy Board (AEB) hearings relating to wind generation and buried sour gas pipelines. He has supported various parties in interventions relating to interprovincial and interstate pipelines.

Other work by Dr. Rhodes has been in the areas of engineering education, engineering management, corporate management, power line carrier, RF, VHF, and UHF communication systems, microcontrollers, microprocessor and microcontroller programming for real time control, electricity and heat metering, electricity rate and regulatory issues, wind generation, fluorescent lighting, solid state device fabrication and characterization, high vacuum systems, cryogenic physics, semi-stable plasmas, nuclear waste disposal, fast fission and fusion reactors, biofuels and the physics of climate change.

Much of his recent work has been related to liquid sodium cooled modular fast neutron reactors for mitigation of climate change, and further information can be explored at *xylenepower.com* (copy and paste the link https://xylenepower.com into an internet browser). Dr. Rhodes has broad experience that spans almost all aspects of energy.
