

Building a Nation:

The Snowy Scheme

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In 1967, before it was even finished, the American Society of Engineers rated the Snowy Mountains Scheme as "one of the seven engineering wonders" of the modern world.

The Snowy Scheme is the largest single infrastructure project in Australian history, and an appreciation of its magnitude, and the way in which it transformed postwar Australia, provides a model of how, once again, to think in terms of building our nation.

The scheme took one generation to build, from 1949 through 1974. It was finished on time, and under budget, for \$820 million for a national asset which will last for hundreds of years. Over 100,000 people worked on the Snowy Scheme, two-thirds of them "new Australians", who were given hope and an opportunity to make a new life, and to contribute to building a young nation, Australia, after the death and destruction of World War II, particularly in Europe, where most of the new Australians came from.

The Scheme covers an area of 7,780 km², with sixteen dams, seven power stations (two of which are underground), 145 km of tunnels, and 80 km of aqueducts. It diverts the headwaters of the Snowy, Eucumbene and Murrumbidgee Rivers westward through the mountain range, releasing extra water without charge into the irrigation areas of the Murray and Murrumbidgee. The heart of the scheme is Lake Eucumbene, the Scheme's biggest reservoir, with a volume nine times that of Sydney Harbour. From there, huge underground tunnels carry water to and from the two major parts of the Scheme, the Tumut (and on to the Murrumbidgee) and the Murray.

The generators of the Scheme are large enough to produce up to 17% of southeastern Australia's energy requirements, but produce only 5% because of the limited amount of water available. However, the Scheme's large capacity enables it to produce a lot of power for short periods, which, among other things, means it can provide emergency support to the electricity systems of southeastern Australia in the case of a major blackout, and it could start up a whole electricity system if a total blackout occurred. In emergency situations, hydropower can provide energy within two minutes, compared to the hours or days it takes to crank up a coal or oil burning plant.

The Scheme transformed Australia in many ways. For the construction industry, for instance, according to Martin Albrecht, Managing Director of Thiess Contractors Pty. Ltd., one of the Australian firms which played a key role in building the Snowy,

"The experience gained by individual engineers participating in the Snowy Scheme had a profound influence on the culture of the construction industry beyond the life of the scheme. The early 1960s saw rapid growth of Australian heavy construction, including roads, railways, pipelines, dams, bridges, ports, coal-fired power-stations, power transmission, mineral processing, materials handling, mining, oil refining and industrial plant. The blossoming Australian contracting industry bolstered by the pool of talent available from the Snowy Scheme greatly facilitated this growth."

Many of the engineers who had worked on the Snowy took up leading positions with engineering firms in Australia and internationally, while others took up senior positions in other governmental construction Authorities, like the Hydro-Electric Commission of Tasmania, the Electricity Commission of NSW, and the Sydney Water Board. The Snowy also had a profound impact on safety practices (it was the first project to mandate the wearing of seat belts, for instance), in technological processes, and in quality control.

But, perhaps more important, the Snowy transformed Australia's



The Snowy Scheme covers an area of 7,780 km², with 16 dams and seven power stations. sense of what the nation itself was capable of.

Australia had never tackled anything so vast. Initially, most of the contracts and design work were let out to foreign firms. However, very quickly, Snowy Commissioner Sir William Hudson, the legendary figure with sole responsibility for driving the project forward for its first two decades, sent young Australian engineers off to America to study, to learn the techniques employed in the great Tennessee Valley Authority (TVA) project which covered seven states, and which the U.S. Bureau of Reclamation had used in building the great American dams, such as the gigantic Hoover and Grand Coulee dams in the American West. As Martin Albrecht recalled,

"William Hudson adopted the practice of talking to most of his engineers individually on their return home. His persistent questioning generally led to the observation by the returning engineer-trainee that 'we are individually just as competent and as well educated as the American engineers. If we work together and use management systems as they do, we can become world-class here, too.' To this William Hudson would sum up 'that is the main lesson I sent you to the USA to learn. We must get rid of our Australian technical and cultural inferiority complex.'"

But perhaps the best way to appreciate the Scheme, is from the account of one individual deeply involved in it, one of the first group of twelve young engineers whom William Hudson sent to America to be trained, Prof. Lance Endersbee.

The Snowy Vision

by Emeritus Prof. Lance Endersbee AO, FTSE

The concept of the Snowy Mountains Scheme captured the imagination of all those involved.

From the beginning, the challenges of the project attracted young and capable people. They were supported by wise leadership, and encouraged to accept tasks to the full limit of their capacity. They had access to the best world experience.

As the work proceeded, new challenges arose. Problems were being solved as they arose in practice, and innovations were being adopted without any delays to the overall progress. There was excellent co-operation within the Snowy team of engineers involved in investigation, design, and contract administration, geologists and laboratory scientists, and with the contractors. There was a united focus on achievement.

The scheme evolved in overall concept and was improved in detail. The project was finally completed not only on time and within the original estimate, but with much greater installed capacity and electricity output, and with much greater water storage. That ensured secure water releases for irrigation in long term drought.

Plan for the Nation

It is now 50 years since the **Snowy Mountains Hydro-electric Power Act of 1949** was passed by the Commonwealth Government. The time was right.

The nation had almost been invaded during the war. Darwin had been bombed. Ships had been sunk along the east coast.



Nelson Lemmon employed the *Defense Act* to ensure the great Snowy Scheme was built. Photo: Snowy Mountains Hydro-Electric Authority

Enemy submarines had entered Sydney Harbour. During the war, almost all civil works had been deferred. The nation now had to rebuild. There was a need for greater electricity supplies for new industries, and there were blackouts as supplies failed to meet the demand. The international situation had become tense again. There was an Iron Curtain across Europe. It was the time of the Berlin Air Lift.

The Snowy Scheme was a plan for the nation, for national development. The prospect of diverting the Snowy waters inland had been considered for over 60 years, very seriously in times of drought, but always leading to argument between the colonies, and later the states, about the rights to the waters.

In 1941, Mr. L.R. East, Chairman of the State Rivers and Water Supply Commission of Victoria proposed that the Commonwealth and the two states of NSW and Victoria create a separate authority to undertake the work, on the lines of the River Murray Commission. However, the allocation of the diverted waters to the states of NSW, Victoria, and now also to SA, remained contentious.

In 1943 the conflicting proposals for the development of the Snowy waters led Mr. Arthur Calwell, MP, to ask in Parliament that "plans be formulated for the best use of the waters in the interests of the people of Australia as a whole."

In 1946, the Commonwealth and State Ministers from NSW and Victoria finally discussed the national aspect of the project. The engineering investigations for the project became the overall responsibility of the Commonwealth Department of Works and Housing. The Director General was Mr. L.F. Loder (later Sir Louis). The Director of Engineering was Ronald B. Lewis. The detailed work of investigations and evaluation of alternative proposals was the task of E. F. Rowntree, Engineer for Major Investigations.

Rowntree had been a courageous aerial observer in World War I, and had won the Distinguished Flying Cross for several missions at low altitude in the face of heavy machine gun fire. He was a member of a Quaker family in Hobart, but the pacifist Quakers disapproved of his war effort. After World War I he worked with the Hydro-Electric Department in Tasmania, where he designed entire hydro-electric projects virtually single-handedly. His professional background was ideal for the task of developing a plan for the Snowy Scheme.

He assessed many possible alternative layouts. Every varia-



Drilling at the Tooma-Tumut Tunnel, 1959. These great Australians built "one of the seven engineering wonders" of the modern world.

Photo: Snowy Mountains Hydro-Electric Authority

The Snowy Scheme



Two of the six generators at Tumut 3 Power Station can provide enough electricity to power a city the size of Canberra. Photo: Snowy Mountains Hydro-Electric Authority

tion involved site inspections, estimation of river flows, and calculation of reservoir capacity and regulation of storages, outline designs and costs of dams, tunnels and power stations. This task was the sole occupation of Ted Rowntree over about four years. He alone carried out the development of ideas, and studies of economic feasibility. It was a remarkable achievement by one man. Rowntree developed the concept of the diversion of Snowy water to the Tumut River for power and irrigation in the Murrumbidgee Irrigation Area, thereby gaining NSW support for the project.

Another remarkable contribution was by O.T. Olsen, an officer of the State Electricity Commission of Victoria, who had carried out the investigations for the Kiewa hydro-electric project in Victoria, and had studied the potential of the Snowy River from the mountains in NSW to the sea in Victoria. It was Olsen who proposed the diversion of the Upper Snowy River to the Murray River for power production and irrigation along the Murray River. (The development of the significant hydro-electric potential of the Lower Snowy River still awaits its place in time.)

These two concepts came together in the detailed studies by Rowntree, leading to an overall concept that met the objectives of a plan for the nation as a whole. The final reports were presented to the Commonwealth and State Committee, and then to the Premiers' Conference. The next task was to build the project, in circumstances that would be alive with prospects for continued rivalry and procrastination by state governments.

Much of the credit for establishing the Snowy Authority should go to Nelson Lemmon. He was the Minister for Works and Housing in the Australian Government of Prime Minister Ben Chifley. A Western Australian, he was determined that the national interest would prevail, but understood that the Australian Constitution of 1900 did not assign any powers to the Commonwealth to build a project like the Snowy Scheme. The key objectives of the Snowy were to develop electricity and water resources, and these activities remained as residual powers of state governments.

Here is Lemmon's account of what, I believe, is one of the most decisive moments in Australian history:

I went to Chifley ... and I said, "There's only one way to handle this... Put the whole thing under the Defence Act ... and we'll be the boss." He said, "WHAT? Your name's Nelson Lemmon, not Ned Kelly—you can't do that?" So I said, "Why

can't I?" "Well," he said, "you tell me how you can!" So I said, "Listen! You had subs in the Harbour. The way we're building everything now, all they want is a decent cruiser and they could sneak through the guard and they could blow all your power stations out without an effort! You've got Bunnerong built on the water, you've got the big one at Wollongong built on the water ... they could blow all your damned electricity out in one night's shooting! Where'll you produce the arms, where'll your production be with all the power of New South Wales bugged?" Chifley says, "You might get away with it ... If you can get Evatt to agree with it—and if there's a case he'll have to fight it in the High Court—if you can get Evatt to agree, I'll go all the way with you!"

Lemmon went to see Evatt. He knew that Evatt did not like Dedman, who was the Minister for Defence and Minister for Post-War Reconstruction. They were rivals. Lemmon told Evatt that Dedman had said they could not use the **Defence Act**. Evatt's support of Lemmon was immediate. Lemmon had his constitutional defender. At the Premier's conference, Prime Minister Chifley advised the Premiers that the Commonwealth would proceed with the Scheme under the Defence powers. The Premiers were taken by surprise by this decision and simply noted the matter. They then proceeded to the next business.

It was an immense gamble, but there was no other way. Lemmon was aware that the Commonwealth did not even have the power to compulsorily acquire land for the project, as that was a state function. The Commonwealth did not have powers over diversion and use of water resources.

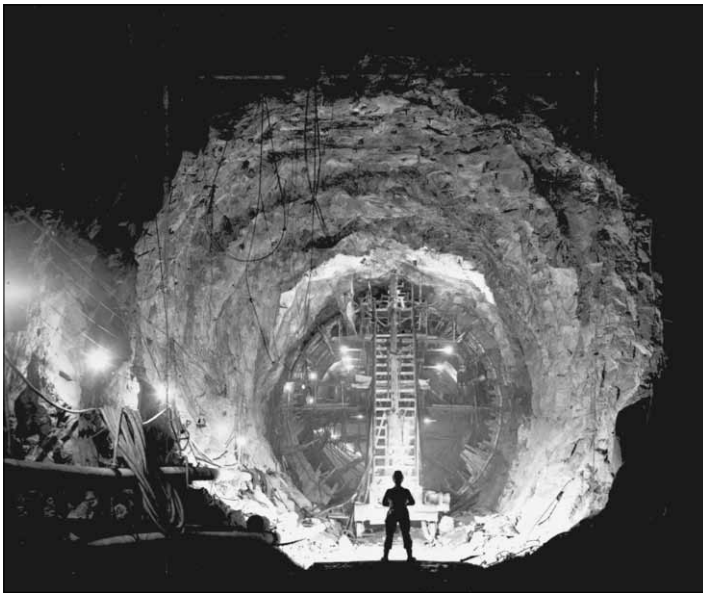
Chifley and Lemmon decided to move quickly towards construction to offset any possible legal challenges from the state governments, especially NSW. For this reason the Snowy Act of 1949 concentrated on the hydro-electric aspect of the Scheme, but not the diversion of water inland for irrigation. The costs of the project were to be recovered from power charges, with the additional water for irrigation being provided at no cost to the benefiting states of NSW, Victoria and SA.

These considerations of residual state rights for public works, under the Constitution, have meant that the Snowy Scheme remains the only national public infrastructure project in the history of our nation.

The project only became possible through the leadership of two groups of outstanding people. It was the engineering experts under Dr L.F. Loder who developed the vision of a national project. It was the political leaders, Prime Minister



The six pipes of Tumut 3 are each 487 metres long, 5.6m in diameter, and collectively contain 10,260 tonnes of steel. Photo: Gabrielle Peut



Right: Underground power station Tumut 1 in construction, 1958. Photo: Snowy Mountains Hydro-Electric Authority

Chifley and Minister Lemmon, who believed that the merits of the grand design outweighed all objections on legal and constitutional grounds, and courageously began the Scheme.

The Leader of the Opposition in the Commonwealth Parliament was Robert Menzies. He formally opposed the proposals of the Government. But he privately congratulated Lemmon after the passage of the **Snowy Act**. Shortly thereafter there was a change of government, and Robert Menzies became Prime Minister. He accepted the decision of Parliament to proceed with the enterprise, supported the Snowy Authority, and ably dealt with the constitutional issues that continued to arise as the work proceeded. Menzies ensured the continued flow of funds to meet the needs of the project.

An Organisation for the Task: A Corporation Sole

The administrative form of the Snowy Authority was deliberately chosen to ensure that the construction of the project would proceed unimpeded by changes in the political environment. The construction of the Scheme was seen as an engineering task, and Cabinet preferred the appointment of a single outstanding engineer to manage the Project, unimpeded by any Board or group of experts, or any representatives from state governments. They deliberately chose rule by one man.

The Authority was formally constituted as a single commissioner. Thus the Snowy Mountains Hydro-Electric Authority was, in law, one person. That was a fundamental departure from a normal ministerial department, although the concept of corporation sole had been quite effective in other public enterprises.

In the case of the Snowy Scheme, it was outstandingly successful. There was no indication that the ultimate control of the project by a single commissioner was anything other than beneficial.

It was Nelson Lemmon who selected William Hudson as the Commissioner, and made a single recommendation to Cabinet. The record of the project shows that Hudson was an extraordinarily fine choice, and that the combination of capable leadership and unimpeded authority enabled the huge project to be built on time and within the estimate.

Hudson selected his two Associate Commissioners. Mr T. A. Lang, a young and distinguished civil engineer, and Commissioner of Irrigation and Water Supply in Queensland, and Mr E. L. Merigan, Electrical Engineer, State Electricity Commission of Victoria. Australia had a population of only 8 million in 1949, and there were wide-ranging and critical post-war shortages of men and equipment. It was the beginning of a great adventure.

Creating Competence

The critical challenge from the beginning of the Scheme was the enormous magnitude of the task ahead. There were very few engineers in Australia with experience in projects of that magnitude. The Authority had attracted an initial team of mostly young engineers, many with honors degrees and all with strong potential, but with no experience at all in hydro-electric engineering or major projects. In retrospect, it seems that only the Commissioner had any comprehension of what was involved.

The Authority decided to obtain overseas assistance in the preparation of designs and specifications for certain of the first major projects, and also to train the young engineers to a level whereby the Authority could complete the remainder of the Scheme from its own resources.

At that time many engineers around the world had been inspired by the achievements of the American civil engineers in the imaginative public works they built during the thirties. These projects were undertaken in a deliberate program of national economic recovery from the disastrous effects of the Great Depression. These great U.S. public works included the projects of the Tennessee Valley Authority, and many big projects by the U.S. Bureau of Reclamation such as Hoover Dam, and the Central Valley Project in California. This strong example in America undoubtedly aided the acceptance of the idea of the Snowy Scheme in Australia, and encouraged Lemmon and Chifley to provide similar direct and vigorous leadership.

The Snowy Authority decided to seek assistance in the United States for the initial group of major projects. This prospect was examined in America by Associate Commissioner T. A. Lang. He proposed an agreement between the Commonwealth of Australia and the United States of America whereby the Bureau of Reclamation would undertake the preparation of designs and specifications for certain tunnel projects and dams, and provide training and experience for a number of Snowy engineers.

At the beginning of 1952, twelve Snowy engineers began work with the Bureau, studying their practices in design and construction of dams and tunnels. Eventually, over 100 young engineers benefited from the program.

I was in the first group of 12 engineers. My own assignment from the Snowy was the study of the design of tunnels and underground structures. The Bureau of Reclamation promptly set me to work in the Denver offices on the actual designs for the Eucumbene-Tumut trans-mountain diversion tunnel, the associated regulating structures, and Junction Intake Shaft.

After 12 months I returned to Cooma with a big bundle of contract drawings and specifications for the Eucumbene-Tumut Tunnel and Associated Structures, Tumut Pond Dam and T1 Pressure Tunnel, hoping I would be able to answer any questions on the details of the projects.

The relationship between the experienced Bureau engineers and the young Australians was exceptionally cordial. We appreciated the way they openly shared their experience with us. They liked the way we were eager to learn, and asked questions.

The happy association with the Bureau of Reclamation was undoubtedly of tremendous benefit to the Authority, and to Australia. The concept of such detailed co-operation with an agency of another government, and the consequent inter-governmental agreement, was an act of much foresight and a credit to all concerned.

Within a few short years of the Authority being formed, the young engineers had matured into a capable, confident and united engineering team.

It is now of interest to reflect that it was all deliberately planned that way.