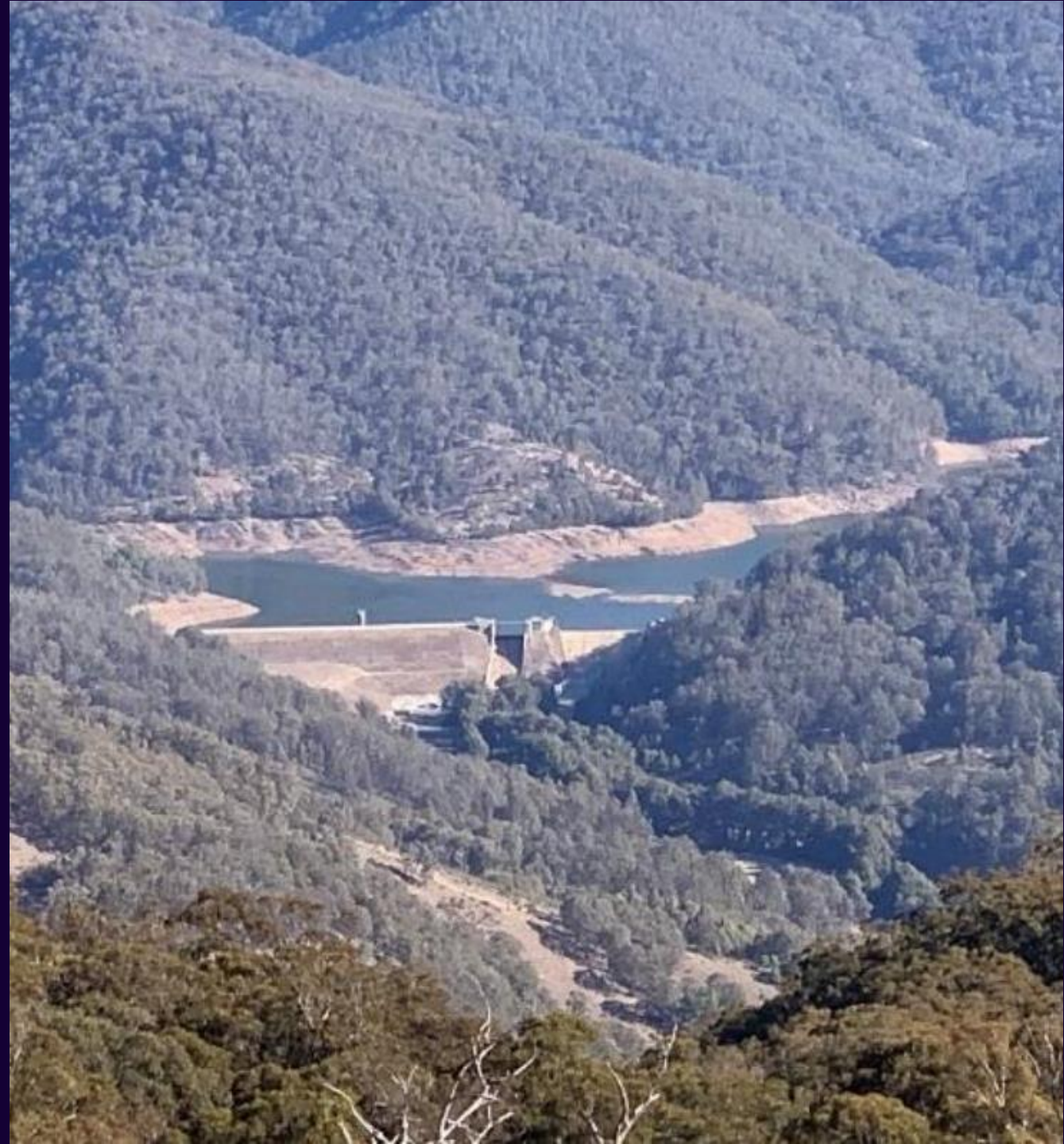
September 2021

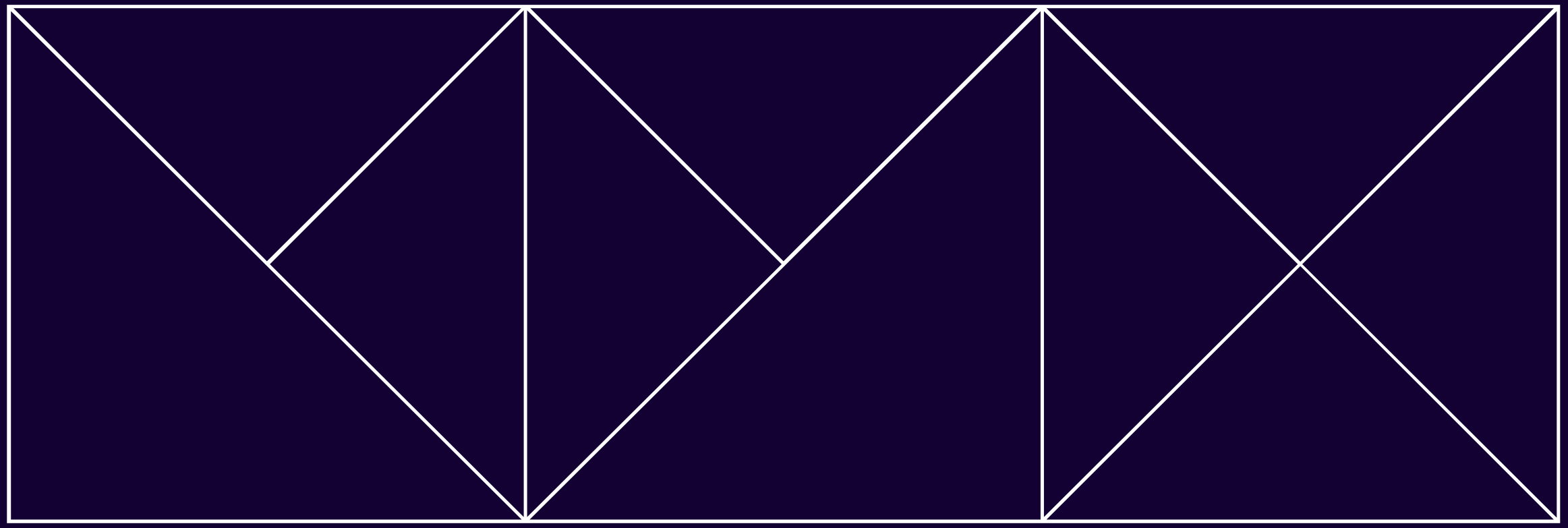
Economic impact assessment of proposed Dungowan PHES Project

Final Report

ACIL ALLEN



Report summary and key findings



Report summary

Energy Estate is proposing to develop the Dungowan Pumped Hydro Energy Storage Project (the Project), located approximately 45km south-west of Tamworth in New South Wales. The Project will be developed on the existing 6.4 megalitre Dungowan Dam and take advantage of the deep gorges to the east and south to create a pumped hydro energy storage (PHES) project.

Energy Estate have commissioned ACIL Allen Consulting (ACIL Allen) to help understand the economic impacts that the development of the Project will provide to the local and national economies. This report sets out the findings of this assessment. The results are presented in the form of the direct and indirect economic impacts of the development on the economies of the local region and New South Wales over the life of the project.

To understand the results, it is useful to consider what is meant by direct and indirect impacts. In the case of employment, the direct jobs created by the project are easy to identify and quantify. For the Dungowan Project there are an estimated 500 full time equivalent (FTE) jobs required over five years of construction and an average of 35 FTE workers in each year of operation.

Additional benefit to the economy, however, is obtained through the indirect jobs resulting from the construction and operation of the Project. These indirect jobs result from the purchases made by Verdant during construction and operation from Australian businesses. As a result, these businesses increase their production and their inputs into production, particularly in relation to labour. In other words, these local businesses purchase more goods, services and labour to operate their businesses. This effect continues down the supply chain creating jobs at each stage.

Key findings

GROSS PRODUCT

IMPACT RESULTS
Local Region: $2.51bn ($57m p.a.)
New South Wales: $2.54bn ($58m p.a.)
Australia: $2.34bn ($53m p.a.)

Much of the economic value from the Project is generated in the Local Region and New South Wales.

INCOME

IMPACT RESULTS
Local Region: $0.4bn ($10m p.a.)
New South Wales : $1.4bn ($33m p.a.)
Australia: $3.8bn ($86m p.a.)

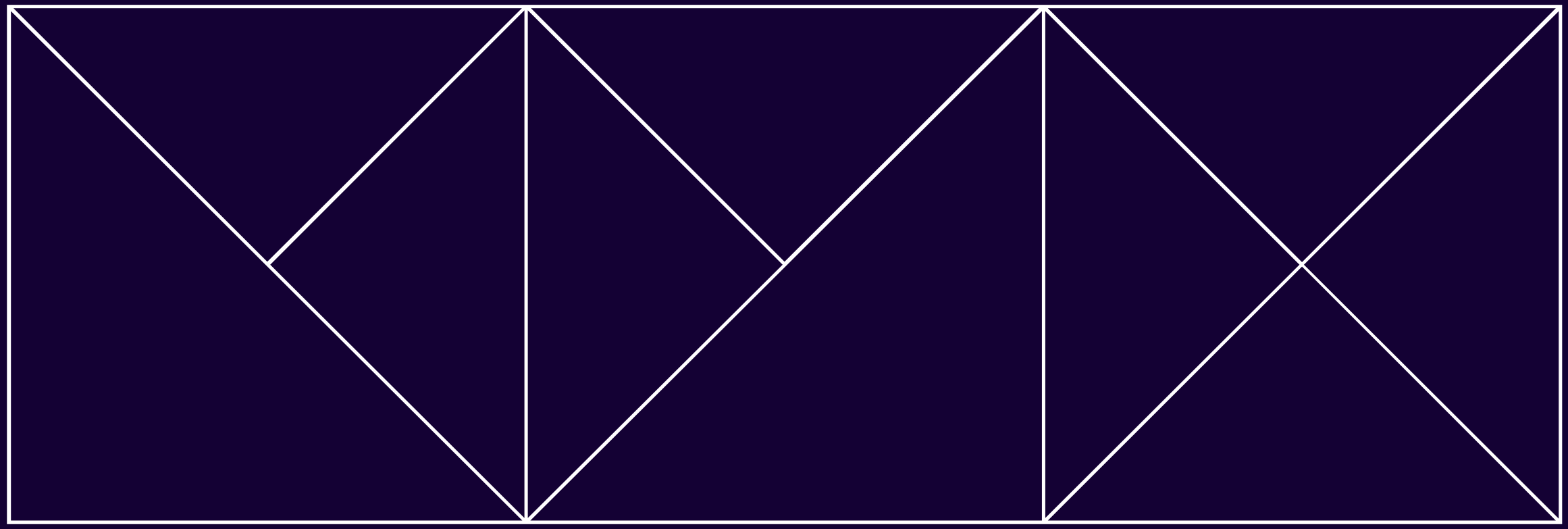
The Project delivers an average real income boost of ~$150 a year per current resident of the Local Region.

JOBS

IMPACT RESULTS
Local Region: 58 FTE p.a.
New South Wales: 71 FTE p.a.
Australia: 88 FTE p.a.

During the operation phase the Project could increase the population in the Local Region by around 130 persons (assuming some workers bring their families).

Project overview



The Project

The Dungowan Project is located within the New England region of New South Wales approximately 45km south-west of Tamworth. For the purposes of this analysis the Local Region has been defined to the combination of two Local Government Areas (LGAs), comprising the Tamworth Regional LGA and the Walcha LGA.

The Project will involve an investment of approximately $568 million over 5 years to build a 300 MW PHES for electricity generation starting in July 2026. Approximately 22% of the investment is expected to be spent within the Local Region (primarily on labour), with a further 30% expected to be spent on goods and services sourced from the rest of New South Wales. Just over 20% of the total capital expenditure is expected to be directly sourced from overseas suppliers – primarily related to the generators and electromechanical systems.

Besides the generators and electromechanical systems, capital expenditure will mostly be related to civil works related to building waterways and lined turkey nests. On average, 500 direct FTE workers a year are expected to be involved in the construction, with more expected to be required in the first half of the construction phase.

Major refurbishments in the order of $100 million are expected to occur every 40 years, primarily related to replacing electromechanical components.

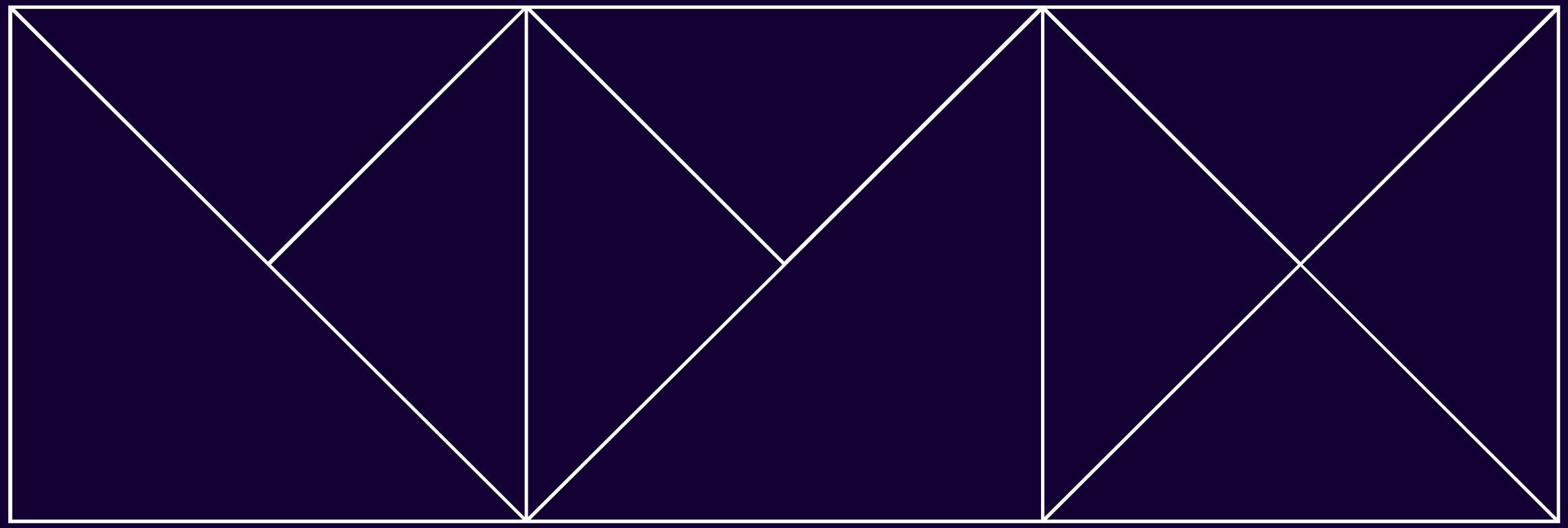
The Project is assumed to begin operating in FY2026 with a life of at least 80 years. For the purposes of this assessment, just the first 40 years of operations to the first refurbishment have been modelled.

Annual operating expenditure is expected to be relatively small at $8.5 million a year, with ongoing employment of 35 FTE workers. Approximately 85% of operating expenses will be spent in the Local Region, with a further 10% from the rest of New South Wales.

Revenue will change year to year based on market conditions but is expected to average around $70 million a year through to 2050.

Figure 1: Location of Dungowan PHES Project

Methodology



Methodology

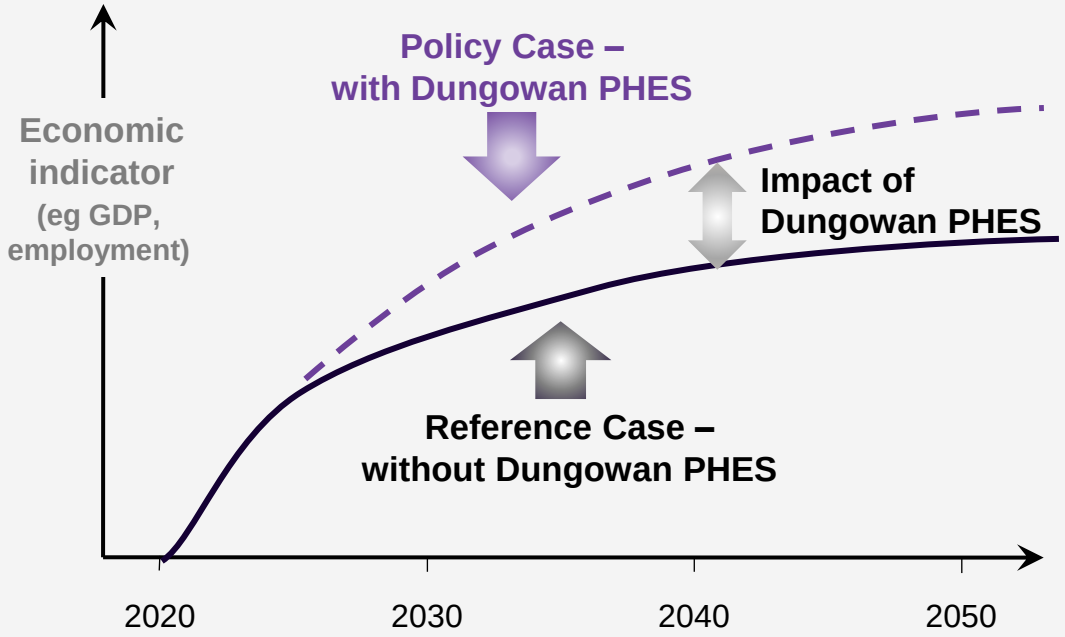
Regional economic impact modelling was undertaken using computable general equilibrium (CGE) modelling. For this analysis, ACIL Allen's CGE model, *Tasman Global*, was used to estimate the regional, Territory, and national economic impacts of the construction and operation activities associated with the Ammaroo Project.

In applications of the *Tasman Global* model, a Reference Case simulation forms a 'business-as-usual' basis with which to compare the results of various simulations. The Reference Case provides projections of growth in the absence of the Dungowan project in terms of Gross Product, population, labour supply, industry output and so on and provides projections of endogenous variables such as productivity changes and consumer tastes. The Policy Case assumes all productivity improvements, tax rates and consumer preferences change as per the Reference Case projections but also includes the impacts of the proposed Dungowan Project. The two scenarios give two projections of the economy and the net impact of the Dungowan Project is then calculated as deviations from the Reference Case as illustrated in Figure 2.

Importantly, for the purposes of this modelling, only the economic effects associated with the construction and operation of the Dungowan PHES have been modelled. This analysis has not analysed the potential economic impacts associated with changes in electricity prices.

Further details of the Tasman Global model can be found in Appendix A.

Figure 2: Illustrative scenario analysis using *Tasman Global*



Micro-industry approach

To accurately assess the economic impacts or economic contribution of a major project such as the Dungowan Project, it is necessary to represent the Project in the model's database. An accurate representation can be achieved by establishing the proposed project as a new 'micro-industry' in the database.

The micro-industry approach is so called because it involves the creation of one or more new, initially very small, industries in the *Tasman Global* database. The specifications of each of the micro-industry's costs and sales structures are directly derived from the financial data for the Dungowan Project to be analysed. At the outset, the new industry is necessarily very small so that its existence in the *Tasman Global* database does not affect the database balance or the "business-as-usual" Base Case outcomes.

Besides having a separate cost structure for the Project, a further challenge is to faithfully represent the time profile of the individual cost items. This is particularly important for the investment phase where there are typically large changes in demands for machinery, labour and imported components year on year. This challenge is met in *Tasman Global* by incorporating detailed year on year input changes by source.

Using the micro-industry approach for project evaluations is the most accurate way to capture the detailed economic linkages between the Project and the other industries in the economy. This approach has been developed by ACIL Allen because each project is unique relative to the more aggregated industries in the *Tasman Global* database.

Consequently, in addition to the standard industries represented in *Tasman Global*, the database also identifies the construction and operation phases of the Project as separate micro-industries with their own input cost structure, sales, employment, tax revenues and greenhouse gas emissions based on detailed information generated as part of the analysis.

Another important aspect in the CGE modelling approach used for this analysis is to have separate identification of the capital stock created as part of the Project's investment phase and isolating it until the capital is available for use, thereby preventing the economy gaining false benefits from, say, half a bridge.

Direct versus indirect effects

To understand the results of the analysis, it is important to consider both direct and indirect impacts. In the case of employment, the direct jobs created by the project are easier to identify and quantify. Additional benefit to the economy, however, is obtained through the indirect jobs resulting from the construction and operation of the Project.

These indirect jobs result from the purchases from Australian businesses made by the Project during construction and operation. As a result, these businesses increase their production and their inputs into production, particularly in relation to labour. In other words, these local businesses purchase more goods, services and labour to operate their businesses. This effect continues down the supply chain creating jobs at each stage.

A final stimulus occurs as a result of the profits and taxes generated from the project. It is assumed that the increased profits and Federal Government tax revenues paid during the construction and operation of the Project are distributed throughout Australia proportionate to population.

The same direct and indirect impacts are realised for the contribution the project makes to Gross Product, and income.

Macro-industry impacts

One of the most commonly quoted macroeconomic variables at a national level is real GDP, which is a measure of the aggregate output generated by an economy over a given period of time (typically a year). GDP may be calculated in different ways:

— On the expenditure side by adding together total private and government consumption, investment and net trade.

— On the income side as the sum of returns to the primary factors of production (labour, capital and natural resources) employed in the national economy plus indirect tax revenue.

The regional level equivalent to GDP is GRP – at the state or territory level it is called GSP or GTP, respectively. To reduce the potential confusion with the various acronyms, the term Gross Product has been used in the discussion of the results presented in this report.

These measures of the real Gross Product of an economy should be distinguished from measures of the economy's real income, which provide a better indication of the economic welfare of the residents of a region. It is possible for real Gross Product to increase while at the same time real income (economic welfare) declines. In such circumstances, people and households would be worse off despite economic growth.

In *Tasman Global*, the relevant measure of real income at the national level is real gross national disposable income or RGNDI as reported by the Australian Bureau of Statistics (ABS).

The change in a region's real income as a result of a new project is the change in real Gross Product plus the change in net external income transfers plus the change in the region's terms of trade (which measure the change in the purchasing power of the region's exports relative to its imports). Changes in the terms of trade can have a substantial impact on residents' welfare independently of changes in real economic output.

In global CGE models such as *Tasman Global*, the change in real income is equivalent to the change in consumer welfare using the equivalent variation measure of welfare change resulting from exogenous shocks. Hence, it is valid to say that the projected change in real income (from *Tasman Global*) is also the projected change in consumer welfare.

Discounted future costs and benefits

To compare future costs with future benefits, the future cash flows need to be discounted and brought into present value terms. The need to discount future cash flows can be viewed from two main perspectives, both of which focus on the opportunity cost of the cash flows implied by the timing of payments.

The first perspective is the general observation that individuals prefer a dollar today to a dollar in the future. This is most obvious in the fact that banks need to pay interest on deposits to entice individuals to forgo current spending. This general preference for current consumption is reflected by the 'rate of time preference' and relates to all economic benefits (and costs), not just those that are financial in nature. Since individuals are not indifferent between cash flows from different periods, those flows cannot be directly compared. For monetised flows to be directly comparable in a benefit-cost analysis, those costs or benefits incurred in the future need to be discounted back to current dollar terms. This reflects society's preferences, which place greater weight on consumption occurring closer to the present.

The second perspective is that flows of costs and benefits resulting from the Project also have an opportunity cost for investment. The construction and operation of the Project will impose costs on investors, and those costs will need to be funded in some way. This funding requirement imposes costs on the affected party, either through the interest paid for borrowing the money, or the returns forgone when equity funds are not available to be used for other purposes.

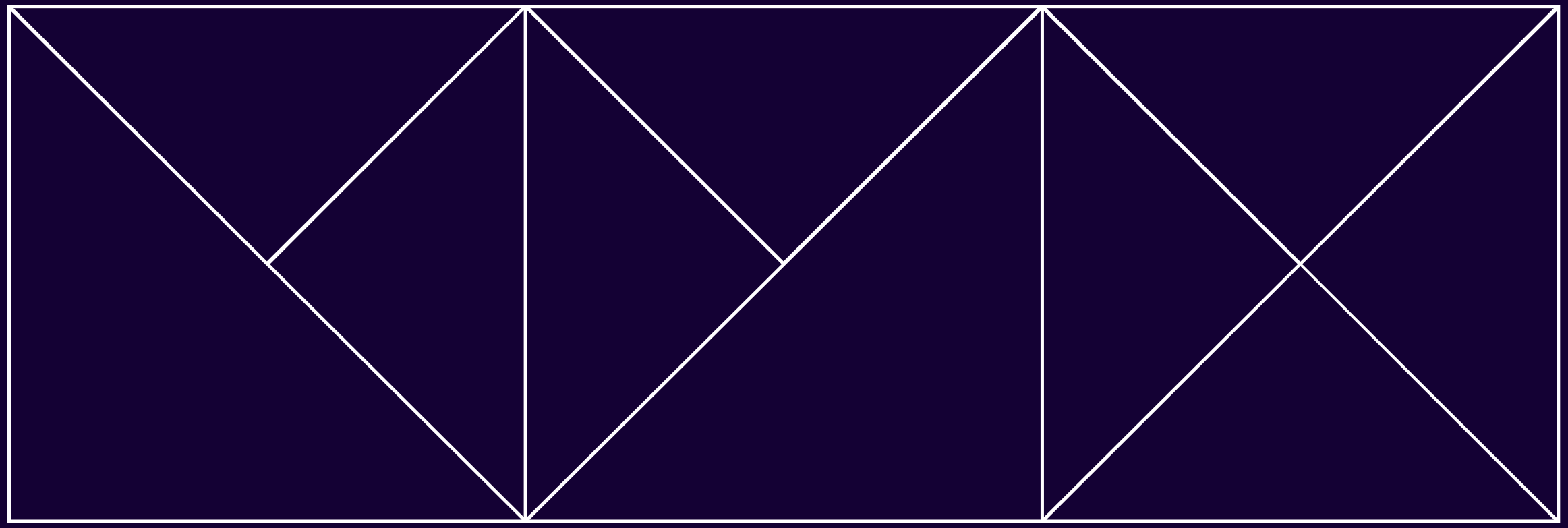
The Dungowan Project would therefore only be beneficial if it provides a return in excess of the cost to society of deferring consumption, or of the return that could have been earned on the best alternative use of the funds. By applying a discount rate to future cash flows, the required rate of return is explicitly taken into account in the net present value calculation.

Both perspectives demonstrate that the need to discount future cash flows can be viewed in terms of the opportunity cost of the cash flows, whether this is the cost of delaying consumption or the alternative investment opportunities forgone. Since most of the costs and benefits of the mine are spread out over time, and their value depends on when they are received, discounting is important to summarising the total net benefit of the Project.

Typically, each option is conducted with one discount rate applied to all benefits and all costs over the entire time frame of interest. In 1970, Kenneth Arrow and Robert Lind explained that this may be inappropriate, because different discount rates should be used depending on the nature of the benefits and costs, including risk and uncertainty, and depending on who is affected. For example, if all costs and benefits are spread across the whole community it could be appropriate to use a risk-free rate. However, if sizeable benefits and costs accrue directly to particular individuals or groups, they also bear the cost of bearing risk and uncertainty, which may be significant. Then, the discount rate should be consistent with the preferences and attitudes of the relevant parties. Therefore, different streams of benefits and costs should be discounted differently, according to whether they accrue publicly or privately. Application of the insights of Arrow and Lind to an assessment of the Project would suggest using a risk-free discount rate for public benefits in the form of employment and provision of infrastructure effects, but a risk-inclusive discount rate for private benefits to investors in the Project. The real options literature has also made a strong case for use of multiple discount rates for different streams of costs and benefits, with different risk and uncertainty attributes.

While quantitative methods for estimating the opportunity cost of capital employed in public projects exist (such as the capital asset pricing model), they are dependent on a range of regularly changing variables (such as the statutory tax rates, equity risk premiums, gearing levels and the risk-free rate). Because of the uncertainty and complexity involved in choosing the 'correct' discount rate for each cash flow stream, and the potential impact that alternative discount rates can have on the net benefit, it is often recommended that different rates should be used in the analysis to demonstrate the sensitivity of results to the discount rate assumption. For example, the Australian Office of Best Practice Regulation recommends the use of three discount rates. For this analysis, ACIL Allen has presented the net benefits of the Project using annual real discounts rates of 3, 7 and 10 per cent, with the lower and upper levels, respectively, reflecting a social rate of time preference and an indicative investor's internal cost of capital, while the 7 per cent rate effectively represents a hybrid of the social and commercial discount rates.

Modelling results



Change in Real Gross Product[1]

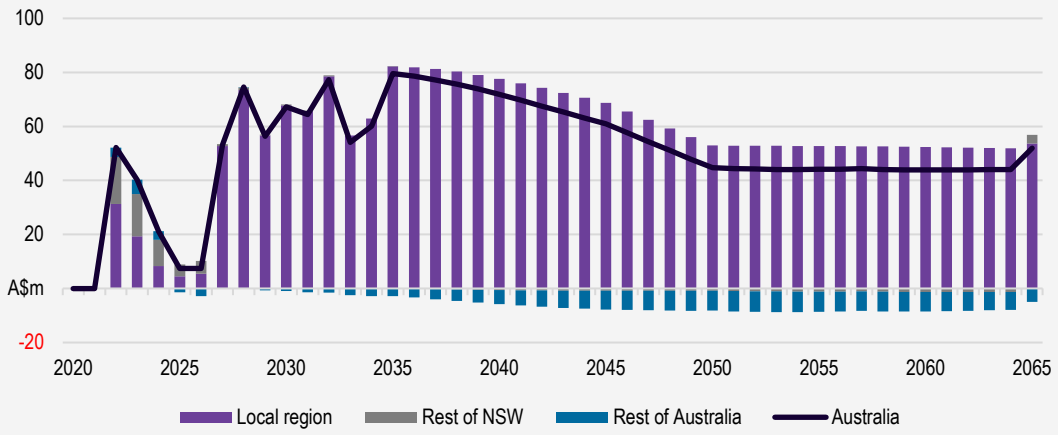
The expenditure in the construction and operation phases of the Dungowan Project will stimulate the economies of the Local Region, New South Wales, and Australia more broadly. The resulting increase in the value of production as a result of the project is referred to as contribution to Gross Product. Gross Domestic Product (GDP) is the final value of the economic output generated by an economy over a period of time (typically a year). It is also a representation of the value added by economic activity, which includes the wages and gross operating surplus of the Project.

ACIL Allen estimates that over the 44-year modelled life of the Project (five years of construction and the first 40 years of operation), the Project will increase Australian real GDP by $2.3 billion, or an average of $53 million a year. In New South Wales, Gross State Product (GSP) is estimated to rise by $2.5 billion (or $58 million a year), almost all of which is generated in the Local Region. Of this:

- $128 million of Australia's additional real GDP is generated during the construction period, with $120 million of additional New South Wales real GSP and $69 million of additional Gross Regional Product (GRP) generated during the construction period.
- $2.2 billion (or an average of $57 million a year) of Australia's additional real GDP is generated during the operations phase. Most of the contribution to the increase in Gross Product during the operations phase will be driven by growth in the Local Region, with just over $2.4 billion added to its GRP, equal to an average of $63 million a year for each year of operation. There is projected to be a small net crowding out of economic activity in the rest of Australia due to the movement of labour and capital into the local region and New South Wales.

The assumed high levels of local content in the Project means that much of the economic value from the Project remains in Australia and particularly in New South Wales.

Figure 3: Change in real gross product – Dungowan PHES project ($ million, 2021 terms)



Source: ACIL Allen

Table 1: Projected Change in real Gross Product as a result of the Dungowan PHES project – total project (in real 2021 terms)

	Total (2022–2065)	Average (2022–2065)	NPV 3% real	NPV 7% real	NPV 10% real
	2021 $Am	2021 $Am	2021 $Am	2021 $Am	2021 $Am
Local Region (real GRP)	2,512	57	1,301	645	422
New South Wales (real GSP)	2,544	58	1,341	685	460
Australia (real GDP)	2,343	53	1,260	660	449

Notes: NPV = net present value using real discount rate. All years are financial years ending June 30. The Local Region comprises the Tamworth Region and Walcha LGAs.
Source: ACIL Allen

[1] Real Output is the broadest measure of economic activity. It represents the total dollar value of finalised goods and services produced over a specific time period and is considered as a measure of the size of an economy. At a national level, it is referred to as Gross Domestic Product (GDP); at the state level, Gross State Product (GSP); and, at a regional level, Gross Regional Product (GRP).

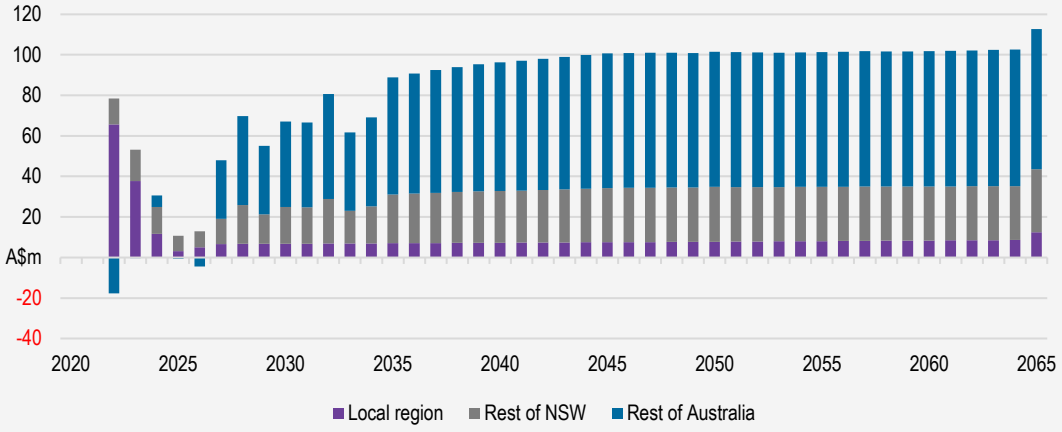
Change in Real Income[2]

Real income is a measure of the ability to purchase goods and services, adjusted for inflation. A rise in real income indicates a rise in the capacity for current consumption, but also an increased ability to accumulate wealth in the form of financial and other assets. The change in real income from a development is a measure of the change in the economic welfare of residents.

The construction and operation of the Dungowan Project will directly and indirectly boost incomes in the local economy, largely through the direct wages and salaries to workers providing labour services to the Project. There will also be indirect impacts on incomes in the wider economy including from the supply chain that supports the Project and some benefit from locally retained profits. At the broader state and national levels, there are the same income sources as the local economy, but also relatively more significant benefits from the redistribution of wealth from the profits of the project and from state and national taxes.

ACIL Allen estimates that over the modelled period of the Project (five years of construction and 40 years of operation), the Project will generate $3.8 billion towards the incomes of the residents of Australia or an average of $86 million a year. In New South Wales, real incomes are estimated to rise by $1.4 billion or $33 million a year, while in the Local Region, incomes will rise by nearly $434 million over the life of the project or an average of $10 million a year.

Figure 4: Change in real incomes: Dungowan PHES Project ($ million, 2021 terms)



Source: ACIL Allen

Table 2: Projected Change in real income as a result of the Dungowan PHES Project – total project (in real 2021 terms)

	Total (2022–2049)	Average (2022–2049)	NPV 3% real	NPV 7% real	NPV 10% real
	2021 $Am	2021 $Am	2021 $Am	2021 $Am	2021 $Am
Local Region	424	10	257	167	135
New South Wales	1,439	33	755	405	290
Australia	3,774	86	1,834	861	555

Notes: NPV = net present value using real discount rate. All years are financial years ending June 30. The Local Region comprises the Tamworth Region and Walcha LGAs.
Source: ACIL Allen

[2] Real income is a measure of the welfare of residents in an economy through their ability to purchase goods and services and to accumulate wealth. In CGE models such as Tasman Global, he change in real income is a measure of the change in economic welfare.

Change in Employment[3]

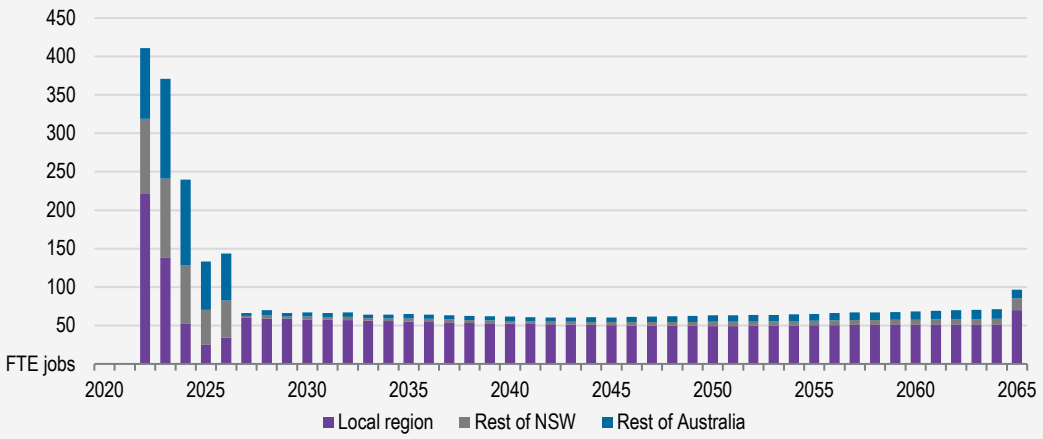
The Project will result in job creation in the form of direct and indirect employment. The direct employment refers to those jobs required to construct and operate the project. There will also be indirect jobs that are created by the additional spending in the economy on goods and services, including wages, to construct and operate the project. This includes the spending of the increase in net income as a result of the Project. It also includes the contractor workforce.

The Project will result in net migration of people from other parts of Australia to live in the Local Region and in New South Wales more generally.

While the movement of workers to the Local Region during the construction phase will be larger, it will only occur over the five years of construction (and mostly during the peak on-site period in the first 2-3 years). The flow of workers to the region during the operation phase will be more stable and of a longer term nature. Importantly, job creation as a result of the development of the Project represents long term structural diversification of the jobs market in the Local Region.

Over the modelled life of the Project, a net total of 3,857 full time equivalent job years will be created in Australia including the jobs directly employed on the Project in construction and operation as well as the contractor workforce and other flow on job creation. This includes an average of 58 full time equivalent (FTE) jobs a year in the Local Region, and 71 FTE jobs a year in New South Wales as a whole. The net impact in Australia is equivalent to an average of 88 FTE jobs in each of the 28 years of the Project.

Figure 5: Projected change in total employment in each region as a result of the Dungowan PHES Project, relative to the reference case (full-time equivalent jobs)



Source: ACIL Allen

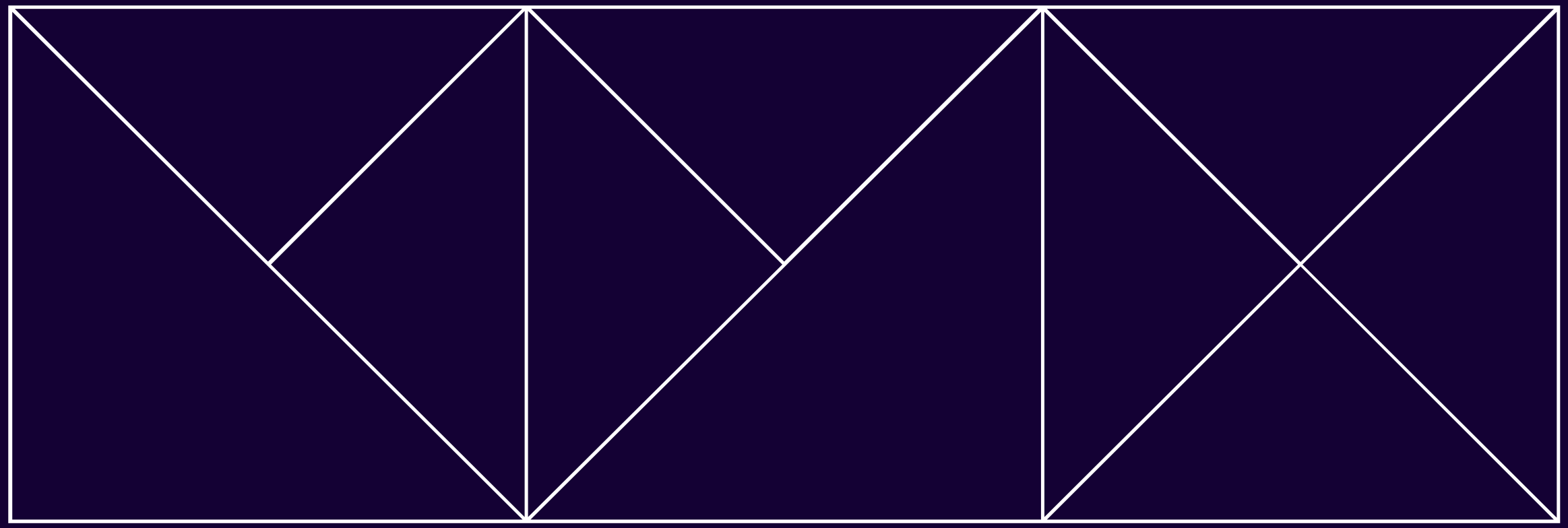
Table 3: Job creation: Dungowan PHES Project: total (number of FTE job years)

	Average annual net job creation (FTE jobs)		Total net increase in jobs over life of project (FTE job years)
	Construction phase	Operations phase	Employee years
Local Region	94	53	2,538
New South Wales	168	58	3,108
Australia	260	66	3,857

Note: Employment by place of residence
Source: ACIL Allen

[3] Real employment is measured in job years. A job year is employment of one full-time equivalent (FTE) person for one year.

Appendix A



Overview of *Tasman Global*

Tasman Global is a dynamic, global computable general equilibrium (CGE) model that has been developed by ACIL Allen for the purpose of undertaking economic impact analysis at the regional, state, national and global level.

A CGE model captures the interlinkages between the markets of all commodities and factors, taking into account resource constraints, to find a simultaneous equilibrium in all markets. A global CGE model extends this interdependence of the markets across world regions and finds simultaneous equilibrium globally. A dynamic model adds onto this the interconnection of equilibrium economies across time periods. For example, investments made today are going to determine the capital stocks of tomorrow and hence future equilibrium outcomes depend on today's equilibrium outcome, and so on.

A dynamic global CGE model, such as *Tasman Global*, has the capability of addressing total, sectoral, spatial and temporal efficiency of resource allocation as it connects markets globally and over time. Being a recursively dynamic model, however, its ability to address temporal issues is limited. In particular, *Tasman Global* cannot typically address issues requiring partial or perfect foresight. However, as documented in Jakeman et al (2001), it is possible to introduce partial or perfect foresight in certain markets using algorithmic approaches. Notwithstanding this, the model does have the capability to project the economic impacts over time of given changes in policies, tastes and technologies in any region of the world economy on all sectors and agents of all regions of the world economy.

Tasman Global was developed from the 2001 version of the Global Trade and Environment Model (GTEM) developed by ABARE (Pant 2001) and has been evolving ever since. In turn, GTEM was developed out of the MEGABARE model (ABARE 1996), which contained significant advancements over the GTAP model of that time (Hertel 1997).

Tasman Global is a model that estimates relationships between variables at different points in time. This is in contrast to comparative static models, which compare two equilibriums (one before an economic disturbance and one following). A dynamic model such as *Tasman Global* is beneficial when analysing issues for which both the timing of and the adjustment path that economies follow are relevant in the analysis.

A key advantage of *Tasman Global* is the level of detail in the database underpinning the model. The database is derived from the Global Trade Analysis Project (GTAP) database (Aguiar et al. 2019). This database is a fully documented, publicly available global data base which contains complete bilateral trade information, transport and protection linkages among regions for all GTAP commodities. It is the most detailed database of its type in the world.

Tasman Global builds on the GTAP database by adding the following important features:

- a detailed population and labour market database
- detailed technology representation within key industries (such as electricity generation and iron and steel production)
- disaggregation of a range of major commodities including iron ore, bauxite, alumina, primary aluminium, brown coal, black coal and LNG
- the ability to repatriate labour and capital income
- explicit representation of the states and territories of Australia
- the capacity to represent multiple regions within states and territories of Australia explicitly.

Nominally, version 10.1 of the *Tasman Global* database divides the world economy into 153 regions (145 international regions plus the 8 states and territories of Australia) although in reality the regions are frequently disaggregated further. ACIL Allen regularly models Australian or international projects or policies at the regional level including at the or at the state/territory/provincial level for various countries.

The *Tasman Global* database also contains a wealth of sectoral detail currently identifying up to 76 industries. The foundation of this information is the input-output tables that underpin the database. The input-output tables account for the distribution of industry production to satisfy industry and final demands.

Industry demands, so-called intermediate usage, are the demands from each industry for inputs. For example, electricity is an input into the production of communications. In other words, the communications industry uses electricity as an intermediate input.

Tasman Global also has a detailed representation of the Australian labour market, recognising 97 different occupations within Australia, and producing results in terms of impacts on labour supply, participation rates and unemployment rates.

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