

DRAFT

**SETTLEMENTS RESIDUE AUCTION
INFORMATION MEMORANDUM**

Date: 2 June 1998

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ABBREVIATIONS

Market Related

- ACCC - Australian Competition and Consumer Commission
- NECA - National Electricity Code Administrator
- NEMMCO - National Electricity Market Management Company
- NEM - National Electricity market
- IRH - Inter-regional Hedging Contracts

Operations Related

- IRSR - Inter-regional Settlement Residues
- SRA - Settlement Residue Auction
- TSR - Total Settlements Residue
- MLF - Marginal Loss Factor
- RRN - Regional Reference Node
- RSP - Regional Spot Price
- NSP - Network Service Providers
- VoLL - Value of Lost Load
- RR - Intra-regional Settlement Surplus

1. BACKGROUND

The development of the National Electricity Market (NEM) started in 1991 following the acceptance of the Industry Commission recommendations by the Federal and State Governments that major increases in the national productive output could be achieved from restructuring the electricity industry. This meant the introduction of competition in generation and retail supply to customers.

The NEM is designed to achieve the following objectives:

- a. freedom of choice for the electricity buyers
- b. non-discriminatory access to the transmission and distribution networks
- c. no discriminatory legislative or regulatory barriers to entry for new participants in the electricity generation or retail supply: and
- d. no barriers to interstate and / or intrastate trade.

The NEM is a wholesale market for the supply and purchase of electricity combined with an open access regime for use of the transmission and distribution networks in the participating jurisdictions of the Australian Capital Territory, New South Wales, Queensland, South Australia and Victoria. The NEM is defined in the National Electricity Code. This includes the rules and procedures for the wholesale electricity market and the access component for electricity networks. The National Electricity Market Management Company (NEMMCO) will manage and facilitate the wholesale electricity market while National Electricity Code Administrator (NECA) will supervise, administer and enforce the Code. The access component for networks will be regulated by Australian Competition and Consumer Commission (ACCC) and jurisdictional regulators.

As electricity cannot be stored, the wholesale electricity market uses the concept of a pool where all the electricity output from generators is centrally pooled and scheduled to meet the electricity demand. The two basic components of the pool managed by NEMMCO are the centrally coordinated dispatch process and the spot market. In the centrally coordinated dispatch process, electricity supply and demand requirements are continuously balanced by scheduling generators to produce sufficient electricity to meet customer demand. Generators compete by providing dispatch offers (prices for different levels of generation) to NEMMCO. Market customers (retailers and end user customers who are wholesale Market Participants) may submit dispatch bids, comprising prices and associated quantities of demand they wish to be scheduled in the dispatch process. NEMMCO dispatches the scheduled generation and demand with the objective of minimising the cost of meeting electricity demand based on the offer and bid prices.

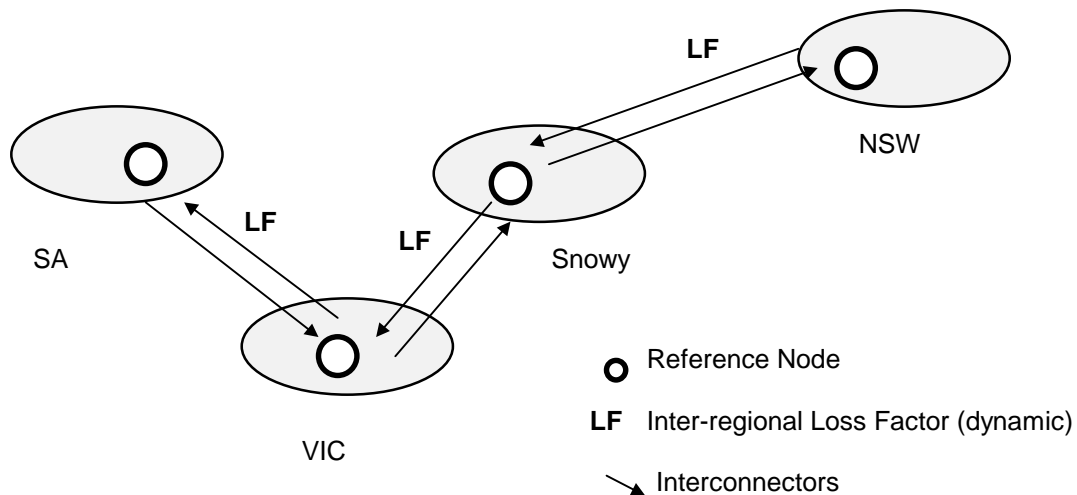
The spot market is the market where generators are paid for the electricity they sell to the pool, and retailers and wholesale end use customers pay for their electricity consumption. All Market Generators and Market Customers settle their electricity sales and purchases from the spot market based on the spot price. The spot price for wholesale electricity is calculated for each half hour period during the day and is the clearing price to match supply and demand. NEMMCO calculates this spot price using the daily price offers and bids. In general, all electricity must be traded through the spot market.

Generators and retailers also trade in financial instruments such as hedge contracts outside the pool to hedge for fluctuations in the spot prices which vary each half hour in response to electricity supply and demand.

2. REGIONS

The National electricity market currently has four interconnected regions. They are the regions of:-

- NSW - New South Wales
- Snowy - Snowy Mountains
- VIC - Victoria
- SA - South Australia



These regions are linked by Transmission lines or interconnectors. These interconnectors, have properties which limit their capability to transport electrical energy.

As a result of the dispatch process, power can flow from one region to another. When the physical power systems linking these regions reach their peak level of capacity to transport the energy, it creates what is called a constraint on the interconnectors linking the regions.

When an interconnector constraint occurs, the normal economic ordering of the dispatch of generation (and dispatchable loads) must be limited or constrained so as not to exceed the interconnector's physical capability. When this occurs the prices in the regions on either side of the constraint can diverge.

When there are no interconnection constraints between regions the regional spot prices only differ by the inter regional loss factors (LF).

The spot price both in and between regions can be volatile due to a range of supply and demand factors. As such, buyers and sellers of electricity may seek to reduce this risk through entering into contracts. These contracts are financial instruments only and do not affect the way the power system is managed by NEMMCO.

If an entity has entered into a financial contract with a party and that contract's reference price is in a region that is separate from its own physical activity (eg.

supply or demand) or other contract position then an inter regional price difference risk (or basis risk) may exist. This risk can be managed by the use of inter-regional hedge contracts (IRH).

3. INTER-REGIONAL SETTLEMENTS RESIDUE

The settlement process for the physical market balances around each price region for supply and demand. As a result of power flowing from a low price to a high price region, the market creates an income stream called the interregional settlement residue (IRSR). The IRSR equates to the price difference between each region times the power flow between the regions. This surplus or residue is to ultimately find its way to customers.

This IRSR is large when the spot price difference times the physical power flow is large, and forms a natural hedge for those with an inter-regional price difference risk.

It has thus been designed that this IRSR be made available to the market via an auction process for those who would value the ability to manage some of the risk of trading between regions.

The process of a Settlement Residue Auction (SRA) is seen to add efficiency to the market by reducing risks in inter-regional trading. This is expected to increase competition across the NEM.

4. OBJECTIVE OF THE PAPER

According to the draft Version 2.0 of the National Electricity Code, NEMMCO was required to:

- issue inter-regional contracts that were unwritten by the inter-regional settlement residue and enter into associated agreements with Network Service Providers (NSPs) and ancillary service providers;
- auction these contracts with a reserve price that would ensure that the settlement residue was recouped;
- establish a trading mechanism to facilitate secondary trade between participants of these contracts;
- undertake secondary trade itself by posting buy and sell prices, as a market maker.

In its determination of authorization of the Code the ACCC indicated that it believed that the efficient inter-regional trade is important to the overall integrity and efficiency of the NEM. However, based upon the issues raised by interested parties, the ACCC had significant concerns that the Code provisions (in Version 2.0) for an interregional contract market were ambitious and may not represent the minimum required in order to commence that market. It highlighted the lack of clear consensus on this matter, questioned NEMMCO's involvement and potential conflicts of interest, and linked this matter to firm access and transmission pricing.

The Commission required the inter-regional contract market provisions be deleted from the Code but recommended that a more appropriate facilitated market be established within three months after the end of the NECA transmission pricing review.

NEMMCO has now convened a large industry working group which developed an interim arrangement to make the settlement residue available to the marketplace, at a price, to enable participants to better manage the risk of trading between regions. The value of this residue is to be passed to NSPs who in turn pass it back to their customers. This interim solution is to be in place close to the start of the NEM and then to progress a long term solution.

The objective of this document is to explain method to determine the settlements residue, define the auction process used to make this residue available to the market place and to define the physical capabilities of the link.

5. PROCESS FOR DETERMINATION OF SETTLEMENT RESIDUES

The NEM Code Clause 3.6.5 requires a methodology to be authorised by NECA for the accounting, allocation and distribution of the total settlements residue due to the application of inter-regional loss factors, intra-regional loss factors and network constraints to each interconnector and each region. This methodology is to be based on the principles that the settlements residue will be allocated and distributed to the appropriate Network Service Providers and used to offset network service charges.

Settlement residue funds arise due to the effect of network losses and inter-regional constraints on the quantities traded in the market and also due to the way in which these losses and constraints are modeled in the market design to influence pool prices. The accumulation of settlements residue can be attributed to either inter-regional or intra-regional sources.

Intra-regional settlements residue accumulates within a region due to the effect of intra-regional transmission losses, intra-regional transmission loss factors, and variations in metering accuracy between participants. Essentially, the intra-regional transmission losses require more energy to be generated than is consumed by customers. This is modeled in the dispatch and settlements processes by way of marginal loss factors to preserve appropriate pricing signals, but the use of such marginal loss factors results in an over-recovery of funds in each billing period. Metering accuracy variations further influence the balance of settlements funds, and hence the size of the over-recover and the intra-regional residue amount.

Inter-regional settlements residue on the other hand, accumulates due to the effect of both interconnection losses and constraints.

Interconnection losses are modeled in the NEM as a marginal loss factor that is dependent on interconnection flow and the distribution of generation, and hence results in a price differential between two neighbouring regional reference nodes.

Interconnection constraints will cause much larger price differential between regions. In both of these cases, the exporting regional price will normally be lower than the importing regional price. These inter-regional price differentials will result in an overall settlement imbalance (surplus) due to customers paying a higher price for the imports than the generators in the exporting region are paid for generating the exports.

The settlement residue funds will be determined using the following broad process. The methodologies referred to in this process are developed further at a later stage in this document.

- Identify the Total Settlements Residue (TSR);
- Subdivide the TSR into the following component parts:
 - Intra-Regional Residue for each region (RR_r);
 - Inter-Regional Settlements Residue for each interconnector (IRSR_i);
- Distribute RR to appropriate Transmission Network Service Providers (TNSPs) on a billing period basis. If there is only one TNSP in each region, this allocation is a simple one. If there is more than one TNSP in a region, the RR is to be allocated between them in proportion to the total network charges relating to their connection points in that region for the previous financial year.;
- Allocate IRSR to NEMMCO for use in Settlements Residue Auction (SRA) activities.

5.1 Determination of Total Settlements Residue (TSR)

The Total Settlements Residue for each trading interval or half hour (TSR_t) will be calculated as follows:

$$\text{TSR}_t = \text{total payments for energy made to NEMMCO} \\ \text{less...} \\ \text{total payments for energy made by NEMMCO exclusive} \\ \text{of reallocations).}$$

$$= \text{sum}_{ri} (\text{ML}_i * \text{RSP}_r * \text{MLF}_i) - \text{sum}_{rg} (\text{ML}_g * \text{RSP}_r * \text{MLF}_g)$$

TSR_t = total settlements residue for trading interval 't';

ML_i, = metered load for load 'i';

ML_g = metered load for generator 'g';

MLF_i = marginal loss factor for load 'i';

MLF_g = marginal loss factor for generator 'g'

Generally: MLF = 1 + Δ for load and 1 - Δ for generator respectively

RSP_r = regional spot price for region 'r';

5.2 Calculating the Inter-regional Residue (IRSR_{it}) for each Interconnector

Having determined the total settlements residue, it is possible to apportion that quantity into components representing the Intra-Regional Residue attributable to each Region (RR_{ri}) and the Inter-Regional Settlements Residue attributable to each interconnector (IRSR_{it}).

The calculations are carried out on a trading interval (half hourly) basis using the process as detailed below. This process effectively models each notional interconnector as a generator or load located at the regional reference node, thus preserving the same model as is used in the NEM dispatch process.

For each notional interconnector the inter-regional settlements residue is the difference in value between the energy entering the interconnector at the exporting region and the value of the energy leaving the interconnector in the importing region, as determined at the regional reference nodes.

The following calculation is to be carried out for each notional interconnector for each trading interval (half hour) to determine the value of inter-regional residue for each notional interconnector:

$$IRSR_{it} = RSP_{r2} * IMP_{ir2} - RSP_{r1} * EXP_{ir1}$$

where: $IRSR_{it}$ = Inter-Regional Settlements Residue for notional interconnector 'i' for trading interval 't';

RSP_{r2}, RSP_{r1} = Regional Spot Price for 'region 2' and region 1' respectively;

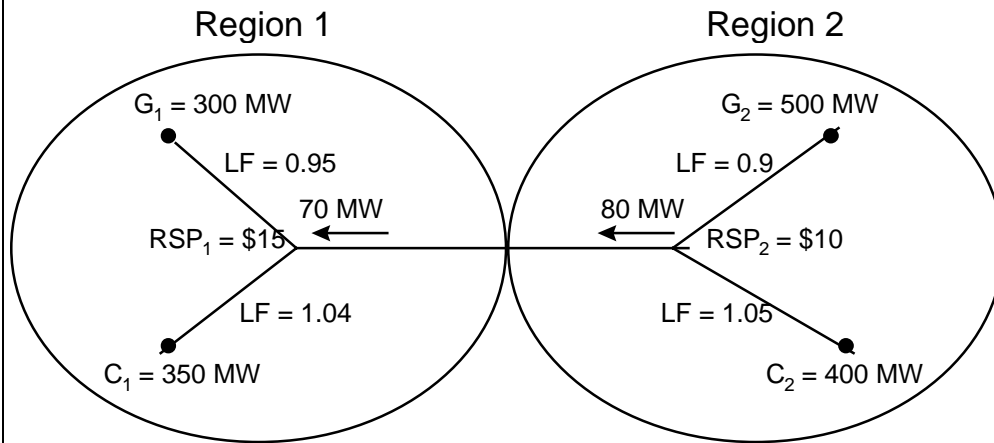
EXP_{ir1} = export flow into interconnector 'i' at reference node 1;

IMP_{ir2} = import flow out of interconnector 'i' at reference node 2.

Trading interval values of $IRSR_{it}$ can then be summed over a billing period to give aggregate billing period values $IRSR_i$ for use in the settlements process.

A separate sum for inter-regional settlements residues is accrued for each direction of interconnector flow. This is required because the funds need to be managed separately for different settlement residue auctions.

Example: Calculation of Residue Values



G_1 paid: $\$15 * 0.95 * 300 = \4275

G_2 paid: $\$10 * 0.9 * 500 = \4500

C_1 paid: $\$15 * 1.04 * 350 = \5460

C_2 paid: $\$10 * 1.05 * 400 = \4200

Total Settlements Residue = Payments by customers - payment to gens
 = $(\$5460 + \$4200) - (\$4275 + \$4500)$
 = $\$885$

Intra - Regional Residues:

Region 1: $(\text{Payment by } C_1) - (\text{Payment to } G_1) - (\text{Import value})$
 = $(\$5460) - (\$4275) - (\$15 * 70)$
 = $\$135$

Region 2: $(\text{Payment by } C_2) - (\text{Payment to } G_2) + (\text{Export value})$
 = $(\$4200) - (\$4500) + (\$10 * 80)$
 = $\$500$

Inter - Regional Residues: = $(RSP_1 * \text{Import}) - (RSP_2 * \text{Export})$
 = $(\$15 * 70) - (\$10 * 80)$
 = $\$250$

Check: Total Settlements Surplus = Intra-regional surplus + inter-regional surplus
 = $\$135 + \$500 + \$250$
 = $\$885$

P.S. SRA is not concerned with Intra-regional Residues and is shown as a matter of information only.

5.3 Determination of the inter-regional transfer quantities IMP_{ir2} , EXP_{ir1}

The calculation of IMP_{ir2} and EXP_{ir2} in the formula above is not straightforward due to the use of notional interconnectors in the NEM market model. Essentially, it is possible to meter the inter-regional transfer quantity at some point on the notional interconnector, but it is not possible to deterministically measure the actual losses on the interconnector, or the flow at each end of the notional interconnector at the regional reference nodes. It is therefore necessary to use a model to represent the losses on the notional interconnector.

A marginal loss factor (MLF) model will be used in the dispatch and pricing process in the NEM for each notional interconnector.

To determine the IMP and EXP values:

- metering the inter-regional flow at a convenient location, and if that is not available, then use the scheduled interconnector flow determined from the on-line dispatch process.
- An average loss factor (ALF), or physical loss model is used to allow the actual loss on the notional interconnector to be calculated from the prevailing system conditions. Consistency with the dispatch model is critical to ensure that physical flows on the system sum correctly.

5.4 Distribution of Intra-regional Settlements surplus (rrr)

Intra-regional residue (RR_r) is to be allocated to registered Transmission Network Service Providers' (TNSPs) in the appropriate region. It is anticipated that there will be only one TNSP operating within each region in the NEM, in which case the allocation will be a simple one.

This allocation will be carried out each billing period as part of the settlement process.

5.5 Distribution of Inter-regional Settlements residue ($IRSR_r$)

Inter-regional settlements residue allocated to regulated interconnectors is assigned to NEMMCO for use in the SRA process. NEMMCO will facilitate the SRA process. This is consistent with the ACCC determination in respect of Authorisation of the Code.

5.6 IRSR Payment Priorities in the event of Settlement default

If there is a settlements default so that NEMMCO is unable to make all the settlements payments, the IRSR has a high priority of payment.

The Code in Clause 3.15.22 sets out a procedure for determining the way in which a shortfall in total settlements payments to NEMMCO is handled. It effectively describes two classes of transactions:

Category A: those which are subtracted from the total amount received from Market Participants; and

Category B: those which are not, and are members of the class for which proportional payment to Market Participants is made.

The subtracted transactions (Category A) are those which NEMMCO is a contracting counterparty i.e. reserve trader contract payments, settlement residues and Participant fees. These amounts are subtracted from the total amount received from Customers, and the balance is distributed to Generators on a pro-rata basis.

The remaining transactions (Category B) are those which NEMMCO is transferring between Market Participants i.e. spot energy, and reallocations. These transactions are listed in Clause 3.15.22 as those for which the part-payment is to occur. The Category A transactions are to be completed in full, even though there was a shortfall, as the corresponding amounts are not included in the pro-rata process.

5.7 Pricing Rules

In all cases the spot prices used in the NEM settlements process are those that would apply in the determination of the IRSR. The NEM Code specifies the pricing rules under both normal and abnormal conditions. Administered pricing rules apply under declared conditions of force majeure and market suspension. These processes are outlined in the NEC Code and related procedures.

It should be noted that there is potential for the IRSR to be a deficit rather than a surplus under some rare circumstances. This would be only expected to occur for limited trading periods.

5.8 IRSR Values

Appendix A lists some modeling results for IRSR values. Clearly these results can vary widely with modeling assumptions and parties need to do their own assessment of these values.

6. AUCTION PROCESS AND RULES

The method to enable the IRSR to be made available to the market place is by way of auction. Interested parties bid for a proportion of the IRSR on one or a combination of interconnectors.

In the auction process a predetermined portion of the inter-regional settlement residue (IRSR) will be sold by NEMMCO.

The auction mechanism is based on monthly contracts and is designed to:

- provide participants with multiple opportunities to bid;
- allow participants to learn during each auction cycle;
- provide protection to customers by limiting the volume on offer in initial tranches.

A timetable is proposed whereby an auction is held each month for 20% of each of the following five monthly contracts except the nearest month, each month being auctioned separately. See Appendix B for details.

The participants in the auction process will include parties that trade physical electricity and those that are already registered with NEMMCO as Code Participants and potentially a number of other parties. These other parties will need to register with NEMMCO.

The auction process will be completed in sufficient time to permit secondary trading to occur - one month before the date of trading.

- i. A proportion of the residue for each direction for each of the three interconnections for each month is auctioned separately.
- ii. An auction is held each month for 20% of each of the following 5 month (except the nearest month).
- iii. The timetable for auction contains some smaller auctions and an accelerated program at the outset.

Linked bids are also to be available in the auction process. The contract term is for one month and a percentage of the option for that given month is to be sold in each of the preceding six months.

Bids for one interconnection or bids for a series of two or three interconnections can be lodged. Eg. Sydney → Snowy, or Sydney → Snowy → Melbourne, or Sydney → Snowy → Melbourne → Adelaide.

The auction process is a sealed bid, uniform price auction with the ability to solve combinational bids. The bid will contain the following information:

- a) Participants Identification.
- b) A ratio for each of the six IRSR quantities, eg. NSW to Snowy; Snowy to NSW; Snowy to Vic; Vic to Snowy; Vic to SA; and SA to Vic,
as 1 : 0 : 2 : 0 : 0 : 0.
This ratio relates to % of IRSR on the links.
- c) Maximum Quantity of ratio's desired eg. 5 would mean 5:0;10:0:0:0. Note: The solution will return successful bids as a percentage of each IRSR value.
- d) Price for specified ratio in \$ eg. \$15,000 per 1%:0:2%:0:0:0.

6.1 Information Release

NEMMCO will provide the following information as part of the auction process. This data is released after the auction and will enhance the ability to assess market values.

- clearing price for each instrument auctioned
- all bids (not identified)
- the allocated percentage for each IRSR
- the price set for each IRSR.

6.2 Auction Mechanism

The auction algorithm is to use a Linear Programming engine to solve for the maximum value of:

allocated quantities times the bid price for all successful bids, subject to constraints of:

- : allocated quantities to be ≥ 0
- : allocated quantities \leq maximum quantity bid
- : total allocated for each IRSR amounts \leq total on offer.

Linked bids for directed IRSR across three regions can be accommodated.

6.3 Instrument Details

The instrument is a simple, non-firm, right to a proportion of a directional IRSR.

The basic instrument is a directional capacity share that is a percentage of the half hourly link settlement residue in a particular direction.

There are six basic instruments to cover the three inter-connectors between the four market regions of NSW, Snowy, Victoria and SA.

6.4 Reserve price - Policy position

The inter-regional settlement residue is ultimately to be returned to customers as an auction trading residue. The revenue obtained from the sale of contracts underwritten by the inter-regional settlement residue is in line with the expected value of the settlement surplus itself.

The jurisdictions will advise on any reserve price policy. In the event of a reserve price being set, it would be one that:

- does not unreasonably restrict trade;
- takes into account only normal inter-regional energy flow and price events (eg. not those experienced in NEM1 on 25 & 26 Nov 1997); and
- takes into account, over time, the prices set in the secondary market.

6.5 Vesting contracts

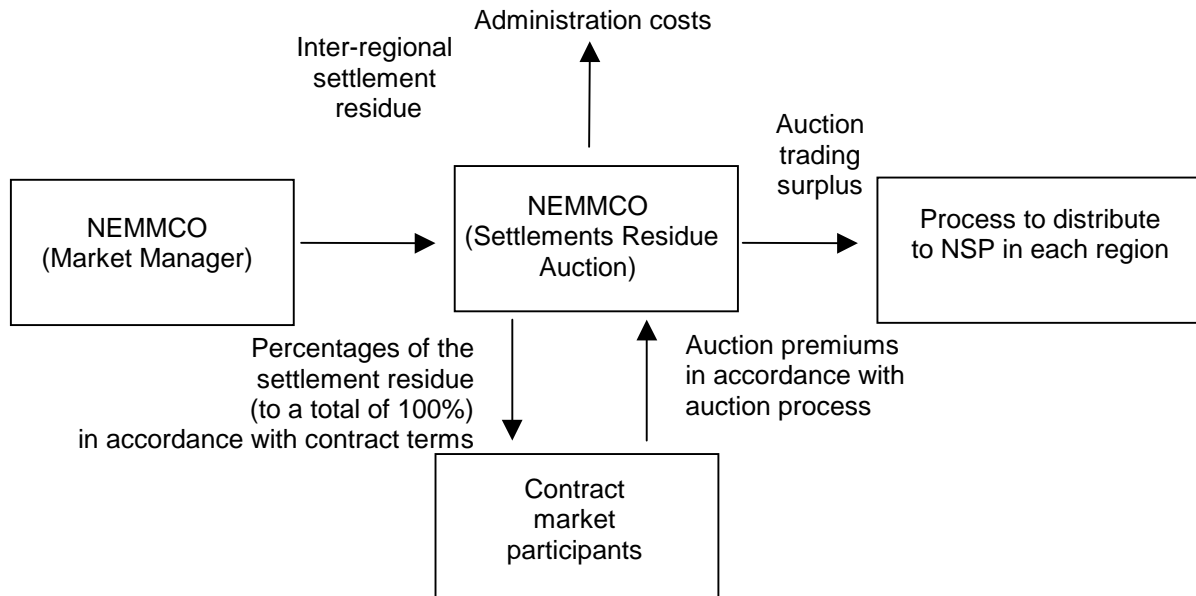
Jurisdictions might wish to vest some entities with inter-regional contracts. The ways in which this is achieved include:

- allocating a proportion of the settlement residue to entities as the residue accumulates; or
- requiring the entities to bid competitively for contracts in the primary or secondary contract markets if they need such contracts, and then compensate them for this, potentially, from the Auction trading surplus allocated to the Jurisdiction NSP.

6.6 Settlement Residue Auction (SRA) Management

The settlements residue auction process will be operated by a ring fenced activity within NEMMCO that provides transparency and accountability to the

market. The process is to be conducted on a full cost recovery, user-pays basis with cash flows as shown in the diagram below.



Auction premiums will recover administration costs and the value of the settlement residue (as a trading surplus).

6.7 Auction Fees and Financial Transactions

NEMMCO would separately account for the Settlement Residue Auction (SRA) in terms of the settlement residue fund. Establishment and on-going costs will be recovered from auction sales fees.

The SRA expenses and administrative costs will be recovered through fees applied in the SRA process and not from market pool fees.

Auction Fee

NEMMCO will set an auction fee based on the percentage purchased for each IRSR.

Auction Value

Each successful bidder will be required to pay the auction price times the successful quantities plus the auction fee within 24 hours of the auction.

NEMMCO Transactions

- Auction Residues

NEMMCO will pay to the NSPs the auction trading surplus from each auction within one business day. These values will be allocated as per the NECA approved allocation for the IRSR.

– Settlement Calculations

NEMMCO Settlements will calculate the values for IRSR in accordance with the NEM Code and NECA approved procedure. These six values are to be available on a 30 minute basis via standard interfaces to participants with a NEM account.

NEMMCO Settlements will determine the sum of the 30 minute values on a daily basis.

IRSR Disbursement

Using the percentage values from the Auction results for the relevant month, the values are to be paid to the successful bidders at least each week and at the end of the calendar month in accordance with the settlement timetable for the NEM.

Note 1: The IRSR allocations relate to calendar months and thus the settlements calculations of IRSR will be determined as daily values and paid in accordance with the NEM Settlements timetable.

6.8 Default Procedures

Where purchasers default on payment of premiums. This defaulting bidder will be liable for the difference between the highest bid and the successful second highest bid.

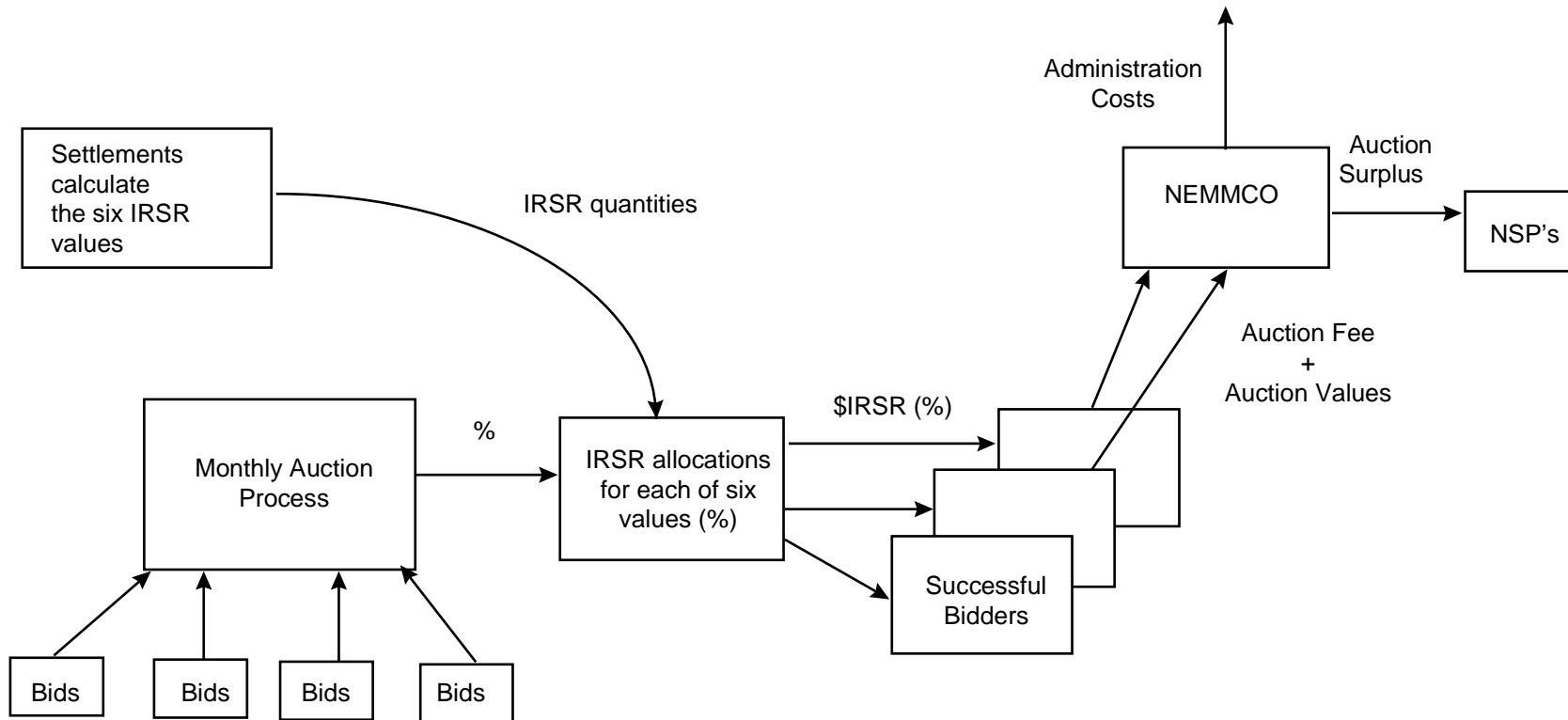
6.9 Novation

The primary IRSR contract is with NEMMCO. No novation of the primary IRSR contract will be permitted. Participants are encouraged to trade via a secondary market to back out of primary positions if required.

6.10 Tax

Participants should take their own advice in regard to taxation. Tax can have a potential impact on the cash flow.

IRSR AUCTION PROCESS



7. INTERCONNECTION PHYSICAL INFORMATION

7.1 Link Capacities

Link Capacity information is available from the "Inter-regional Transfer Limit Equations : Implementation in ESCA SPD" document currently residing on the NEMMCO web site. The System Normal limit equations obtained from this document are reproduced in Appendix C for convenience. Limit equations for prior outage conditions are not available at this time, but will be published in due course.

7.2 Link Augmentations or Major outages

Possible network augmentations that may affect transfer capabilities include:

- Riverlink : If Riverlink proceeds South Australia's maximum import capability will increase from 500 MW to 750 MW. An alternative project is to install a third transformer at Heywood which would increase South Australia's maximum import capability from 500 MW to 650 MW.
- Series capacitors on the Dederang - South Morang 330 kV lines - Should be installed by the end of December 1998. Will restore Victoria's import capability from Snowy to 1500 MW on hot days in summer. (Currently this limit can reduce to 1000 - 1100 MW at these times.)
- Queensland - NSW link - scheduled to be put in service by late 2001, with a capacity of 1000 MW from Queensland to NSW and 500 MW from NSW to Queensland.

7.3 Loss Equations

The inter-regional loss factor equations are provided in Appendix D. The corresponding Inter-regional loss equations are provided in Appendix E.

7.4 Demand/Supply balance documentation

Demand/supply balance information for NSW, Victoria and South Australia will be available in the Summer Outlook document currently being developed by NEMMCO.

Demand/supply balance information for Queensland is available from the Powerlink Queensland 1998 Statement Of Opportunities document.

7.5 Access to historical power flows, link capacities and pool price differentials

Historical inter-regional power flows, link capacities and pool price differentials for NEM1 are available from the TransGrid web site. (They are most likely also available on the VPX web site.)

7.6 Obligations on the TNSPs to provide best endeavours advice of capacities

The code requires that NSPs must advise their planned network outages in accordance with the timetable which are to be converted to network constraints by NEMMCO.

An NSP responsible for an interconnector must arrange for NEMMCO to publish without delay details of capacity profiles for that interconnector which the NSP has agreed with NEMMCO or any other person in connection with the management of risk exposures associated with inter-regional hedge contracts.

APPENDIX A

National Market Scenarios

Three National Market scenarios have been modeled. The three scenarios are :

- Scenario 1 - NSW black coal plant bidding below Victorian Gas plant.
- Scenario 2 - High Victoria to NSW transfer conditions. Victorian generators bidding approximately \$7/MWh below NSW generators.
- Scenario 3 - High NSW to Victoria transfer conditions. NSW generators bidding approximately \$7/MWh below Victorian generators.

Settlement residues have been determined for each of these scenarios using a Monto Carlo modeling program. Average annual Spot Prices for each scenario are in the range \$35 - \$40/MWh. Results are tabulated below.

The studies were performed in early 1996 using an interim set of MLFs and Inter-regional MLF equations and may not accurately reflect current conditions in terms of loss factors and settlement residues.

Inter-Regional Settlement Residues for NEM Scenarios

Scenario 1 : NSW Black Coal bidding below Victorian Gas plant

Transfer Capacity	Flow Direction	Energy (GWh)	Hours Constrained	Constraint Residue (\$M)	IRSR
500	Vic to SA	3039	5058	36.4	42
250	SA to Vic	224	429	5.2	4.6
1500	Snowy to Vic	2412	75	11.5	17
1000	Vic to Snowy	2362	711	6.1	5.9
850	NSW to Snowy	667	120	1.7	0.5
2850	Snowy to NSW	5437	3	0.3	13.8

Scenario 2 : High Victoria to NSW transfer

Transfer Capacity	Flow Direction	Energy (GWh)	Hours Constrained	Constraint Residue (\$M)	IRSR
500	Vic to SA	1094	755	3.6	4.3
250	SA to Vic	402	420	2.6	2.4
1500	Snowy to Vic	325	6	11.1	11.1
1000	Vic to Snowy	5211	1952	12.6	13.3
850	NSW to Snowy	22	1	0	0
2850	Snowy to NSW	9733	6	1.2	19.5

Scenario 3 : High NSW to Victoria transfer

Transfer Capacity	Flow Direction	Energy (GWh)	Hours Constrained	Constraint Residue (\$M)	IRSR
500	Vic to SA	3876	5612	6.6	18.9
250	SA to Vic	83	174	2.3	1.9
1500	Snowy to Vic	6097	85	14.8	29.9
1000	Vic to Snowy	541	49	0.2	0
850	NSW to Snowy	2965	1100	7.3	-0.4
2850	Snowy to NSW	2236	6	1.2	8.3

APPENDIX B

Diagram 1 - NEMMCO Auction Timetable
(includes accelerated start up arrangements)

	Auction Date	Portion of difference monies auctioned							
		Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99
1 st week	Aug-98	10%							
2 nd week	Aug-98	20%	10%	10%	10%				
1 st week	Sep-98	35%	20%	20%	10%	10%			
2 nd week	Sep-98	35%	35%	20%	20%	10%			
1 st week	Oct-98		35%	25%	20%	20%	20%		
1 st week	Nov-98			25%	20%	20%	20%	20%	
1 st week	Dec-98				20%	20%	20%	20%	20%
1 st week	Jan-99					20%	20%	20%	20%
1 st week	Feb-99						20%	20%	20%
1 st week	Mar-99							20%	20%
1 st week	Apr-99								20%
		100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX C: Transfer Equations

Background:

This attachment presents the equations which will be used for determining the transfer capabilities on the interconnectors in the three state interconnected power system comprising New South Wales, South Australia and Victoria.

A number of contingency equations have also been prepared but are not presented here. The contingency equations will be presented in a later, more detailed report. These represent the transfer capabilities for specific prior contingencies which have a major impact on inter-regional transfer capabilities. The contingency equations would be invoked only after the specific contingency has occurred.

South Australia Export to Victoria

The export capability from South Australia to Victoria is generally taken to have a maximum value of 250 MW (although exports in excess of this may be achievable under certain conditions) but may be limited to a lower value by the following equation:

Coefficient		Constant
		371 MW
+	-0.287	* SA Demand (MW)
+	37	* Number of Northern PS units in service
+	24	* Number of TIPS A Units in Service
+	34	* Number of TIPS B Units in Service
+	8	* Number of Mintaro units in service
+	9	* Number of Dry Creek units in service
+	10	* Number of Playford B units in service
+	0.368	* Para SVC MVA reserve
+	0.148	* South East SVC MVA reserve
+	-0.01	* Transfer from Snowy to Victoria (MW)
+	0.005	* Victorian Demand (MW)
+	-0.003	* NSW Demand excluding Snowy (MW)
+	0.093	* Inertia Snowy machines in service (sec on 100 MVA base)
+		Adjustment for prior outages

Victorian Export to South Australia

The export capability from Victoria to South Australia has a maximum value of 500 MW but may be limited to a lower value by either of two equations:

- the Victoria to South Australia export equation; or
- the South Australia - Victoria import equation .

In future revisions the two equations may be combined.

Victoria to South Australia Export Equation

Coefficient		Constant
		488.4 MW
+	-0.0244	* Transfer from Victoria to Snowy (MW)
+	-0.0187	* Vic Demand
+	0.0327	* SA Demand
+	-0.0976	* APD load - 520 MW
+	0.144	* Total Inertia Vic units on line including S/C
+	0.076	* Total Inertia Snowy Units on line
+	0.384	* Nominal reactive margin of SVC's at SESS in MVAr
+	-16.507	Note 1
+	-25	Note 2

Note 1 Confidence Level (MW)

Note 2 Safety Margin (MW)

South Australia -Victoria Import Capability

Coefficient		Constant
		265 MW
+	0.021	* SA Demand (MW)
+	0.045	* SA MVAR metro caps in service
+	21	* Number of Northern PS units in service
+	5	* Number of TIPS A units in service
+	7	* Number of TIPS B units in service
+	2	* Number of Mintaro units in service
+	4	* Number of Playford B units in service
+	1.416	* South East SVC MVAR reserve
+	-0.015	* Victorian Demand (MW)
+	0.146	* Victorian Inertia (sec on 100 MVA base)
+	-0.004	* NSW demand excluding Snowy (MW)
+		Adjustment for prior outages

Victorian Export to Snowy

The maximum export from Victoria to Snowy is taken as the result of the following equation:

Coefficient		Constant	
			1599 (MW)
+	-0.249	*	[Transfer from Victoria to South Australia (MW)]
+	-0.0005896	*	[Transfer from Victoria to South Australia (MW)]**2
+	0.00302	*	NSW Demand
+	-0.362	*	Vic Demand
+	20.269	*	Inertia of Kiewa Hydro
+	7.132	*	Inertia NPSD
+	14.982	*	Inertia Eildon
+	3.351	*	Inertia LV 500 kV Generators (LYPS,HWPS,JLGS,MPS)
+	8.649	*	Inertia LV 220 kV Generators (YWPS)
+	1.841	*	Inertia of Snowy Gen and S/C's (excluding pumps)
+	92.511	*	Angelsea Gen (i.e.: 92.511= on, 0 = off)
+	14.031	*	No of Tumut 3 Pumps in service
+	-41	*	No of ROTS SVC out of service (i.e.: 0 = both on, 1=1 off, 2 = both off)
+	-18	*	if BLTS synch comp out of service
+	-22	*	if FBTS synch comp out of service
+	-17	*	if TSTS synch comp out of service
+	-92.478		Note 1
+	-50		Note 2

Note 1 Confidence Level (MW)

Note 2 Safety Margin (MW)

NSW Export to Snowy

The transient stability capability from NSW to Snowy typically ranges from 1100 MW at times of minimum system demand to about 700 MW at times of peak demand. Thermal limits range from about 1200 MW to about 200 MW for the same conditions. (Source: OM 502).

NSW to Snowy Transient Export Limit

Coefficient		Constant	
			1290 (MW)
+	80	*	No of Bayswater Units in service
+	60	*	No of Liddell Units in service
+	75	*	No of Eraring 1-2 Units in service
+	90	*	No of Eraring 3-4 Units in service
+	40	*	No of Munmorah Units in service
+	85	*	No of Vales B Units in service
+	95	*	No of Wallerawang Units in service
+	150	*	No of Mt Piper Units in service
+	25	*	No of Kangaroo Valley Units in service
+	15	*	No of Bendeela Units in service
+	8	*	No of Koolkhan, Northern, Hunter Valley GT in service
+	0.9	*	Generation at Broken Hill GT (MW)
+	0.25	*	Generation at Shoalhaven (MW)
+	1	*	Generation at Burrunjuck,Hume,Brown Mt, Guthega,Blowering
+	-5	*	No of Murray Units in service
+	15	*	No of Lower Tumut machines in service
+	0.32	*	Total Generation at Snowy
+	-0.00066	*	Generation at Lower Tumut**2
+	-0.14	*	Pumping at Lower Tumut
+	-5	*	No of Jindabyne pumps
+	-0.16	*	NSW demand exl pumps
+	0.1	*	Vic demand exl pumps
+	-9.75	*	Total Inertia of Vic machines in service
+	0.0186	*	[Total Inertia of Vic machines in service]**2
+	3	*	Total Inertia of SA machines in service
+	-0.014	*	[Total Inertia of SA machines in service] **2
+	0.3	*	Transfer from Victoria to South Australia (MW)
-			Reduction due to Bays/Lidd Generation (MW) [Note 1]
+			Adjustment due to prior outages (MW) [Note 2]

Note 1: Due to line outages of either Liddell - Newcastle or Liddell - Tomago 330 kV transmission lines the transient stability export limit must be reduced during periods of high generation at Bayswater and Liddell. These offsets will be calculated as part of contingency constraints which covered in the operating manuals (OM502).

Note 2: As per Note 1, adjustments for other contingencies would be incorporated here.

NSW to Snowy Thermal Export Limit (Continuous Ratings)

Coefficient		Constant	
			1610 MW
-	0.11	*	Mt Piper Generation
-	0.11	*	Wallerawang Generation
+	0.13	*	Kangaroo Valley Generation
+	0.13	*	Bendeela Generation
-	0.12	*	NSW Demand
+	1	*	Burrunjuck Generation
+	1	*	Hume Generation
+	1	*	Brown Mountain Generation
+	1	*	Guthega - Cooma Flow
+	1	*	Blowering Generation
+	1	*	Broken Hill Generation

Snowy Export to NSW

Winter power transfer limits from Snowy to NSW are 2620 (normal) and 3050 MW (emergency).

Summer Power transfer limits are 1990 MW (normal) and 2700 MW (emergency). These limits are determined by the post-contingency rating of the Snowy to NSW 330 kV transmission lines.

The above transfer limits are approximate and are presented here for completeness. The actual transfer limits are determined in accordance with operating procedures and will depend on system conditions.

Snowy Export to Victoria

The export capability from Snowy to Victoria is not determined by transient stability but normally has an upper limit of 1500 MW which is related to the ability to control voltages in the Melbourne metropolitan area and thermal capabilities of the 330 kV transmission lines between Murray and Dederang, Dederang and South Morang, and the Dederang 330/220 kV transformers.

VPX have arranged to install series capacitors on the Dederang to South Morang 330 kV transmission lines by the summer of 1998/99. Subject to voltage control limitations in the Wagga area, this will enable Snowy to export 1500 MW during high summer demand conditions. Previously, exports were limited to around 1100 MW due to voltage control problems in the Melbourne metropolitan area.

APPENDIX D: Inter-Regional LF Equations

1. LF equation (Sydney West 330 referred to Murray 330)

$$= 1.0126 + 8.716 \text{ e-}05 * \text{SNN}_t - 1.110 \text{ e-}5 * \text{N}_d + 3.185 \text{ e-}06 * \text{V}_d$$

2. LF equation (Murray 330 referred to Thomastown 66)

$$= 1.0078 + 9.876 \text{ e-}05 * \text{VSN}_t + 4.228 \text{ e-}06 * \text{V}_d - 1.717 \text{ e-}06 * \text{N}_d - 1.102 \text{ e-}05 * \text{S}_d$$

3. LF equation (Torrens Island 66 referred to Thomastown 66)

$$= 1.00572 + 4.3609 \text{ e-}04 * \text{VSA}_t - 3.926 \text{ e-}06 * \text{V}_d - 8.363 \text{ e-}06 * \text{S}_d$$

where,

V_d = Victorian demand (sent out basis with Morwell G1, 2 and 3, Anglesea PS and Hume PS embedded)

N_d = NSW sent out demand

S_d = South Australian sent out demand

VSN_t = Transfer from Victoria to Snowy

SNN_t = Transfer from Snowy to NSW

VSA_t = Transfer from Victoria to South Australia

APPENDIX E: Inter-Regional Loss Equations

1. Sydney West 330 - Murray 330 notional link average losses

$$\text{Inter-regional loss} = (0.0126 - 1.11 \times 10^{-5} \times \text{Nd} + 3.185 \times 10^{-6} \times \text{Vd}) \times \text{SNNt} + 4.358 \times 10^{-5} \times \text{SNNt}^2$$

2. Murray 330 - Thomastown 66 notional link average losses

$$\text{Inter-regional loss} = (0.0078 + 4.228 \times 10^{-6} \times \text{Vd} - 1.717 \times 10^{-6} \times \text{Nd} - 1.102 \times 10^{-5} \times \text{Sd}) \times \text{VSNT} + 4.938 \times 10^{-5} \times \text{VSNT}^2$$

3. Torrens Island 66 - Thomastown 66 notional link average losses

$$\text{Inter-regional loss} = (0.0057 - 3.926 \times 10^{-6} \times \text{Vd} - 8.363 \times 10^{-6} \times \text{Sd}) \times \text{VSAt} + 2.180 \times 10^{-4} \times \text{VSAt}^2$$

where,

Vd	=	Victorian demand (sent out basis with Morwell G1, 2 and 3, Anglesea PS and Hume PS embedded)
Nd	=	NSW sent out demand
Sd	=	South Australian sent out demand
VSNT	=	Transfer from Victoria to Snowy
SNNt	=	Transfer from Snowy to NSW
VSAt	=	Transfer from Victoria to South Australia