Report D4.1-CAL, December 2015

Auctions for Renewable Support in California: Instruments and lessons learnt

AURES

HORIZON 2020

Short about the project

Auctions for Renewable Energy Support: Effective use and efficient implementation options (AURES)

This project helps assessing the applicability of different auction types to renewable support under different market conditions. It also explores which auction types and design specifications suit particular requirements and policy goals in European countries. By establishing best practices and a knowledge sharing network, we contribute to informed policy decision-making and to the success of auction implementations across Europe.

Target-oriented analysis: Through analysis of empirical experiences, experiments and simulation, we will create a flexible policy support tool that supports policy makers in deciding on the applicability of auction types and certain design specifications for their specific situation.

Capacity building activities: We undertake specific implementation cases to derive best practices and trigger knowledge sharing amongst Member States. We strive to create a strong network with workshops, webinars, bilateral meetings, newsletters, a website that will serve as capacity building platform for both policy makers and market participants (including project developers, auctioneers, etc.). Wherever required, we can set up specific bilateral and multilateral meetings on specific auction issues and facilitate cooperation and knowledge sharing. Additionally, we offer sparring on specific implementation options, drawing from insights gained during the first phases of the project (empirical analysis of previous auctions in Europe and the world), conceptual and theoretical analysis on the applicability of specific designs in certain market conditions and for certain policy goals issues and facilitate cooperation and knowledge sharing. Additionally, we offer sparring on specific implementation options, drawing from insights gained during the first phases of the project (empirical analysis of previous auctions in Europe and the world), conceptual and theoretical analysis on the applicability of specific designs in certain market conditions and for certain policy goals.

Project consortium: eight renowned public institutions and private firms from five European countries and combines some of the leading energy policy experts in Europe, with an impressive track record of successful research and coordination projects.

This report deals with the Renewable Auction Mechanism (RAM) in California, which was introduced to support the growth of renewable distributed generation between 3 and 20 MW.

The report contributes to the first and second of three tasks in work package 4 of the AURES project:

T4.1 Providing a characterisation of the different auctions

T4.2 Making an assessment of auctions and case-specific lessons learnt

T4.3 Interpreting and summarise the general lessons learnt and resulting and thereby outline specific recommendations

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Auctions for Renewable Support in California: Instrument and lessons learnt

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Project deliverable:
WP4 - Empirical aspects of auctions for RES-E: Learning from real experiences.
Task 4.1 Characteristics of auctions
Task 4.2 Assessment of auctions and case-specific lessons learnt

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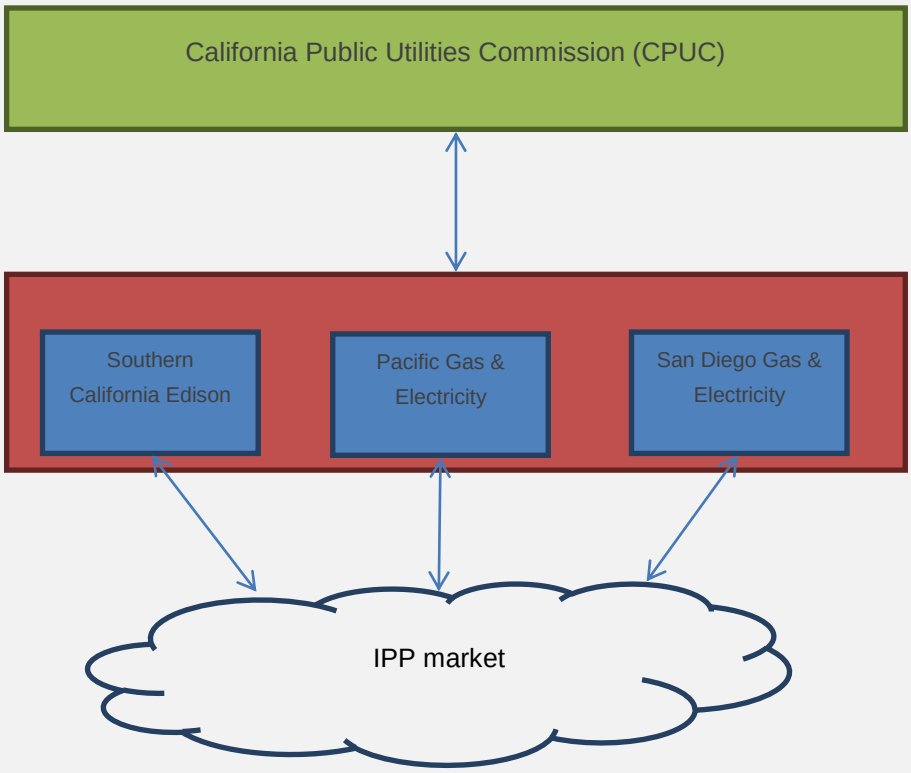
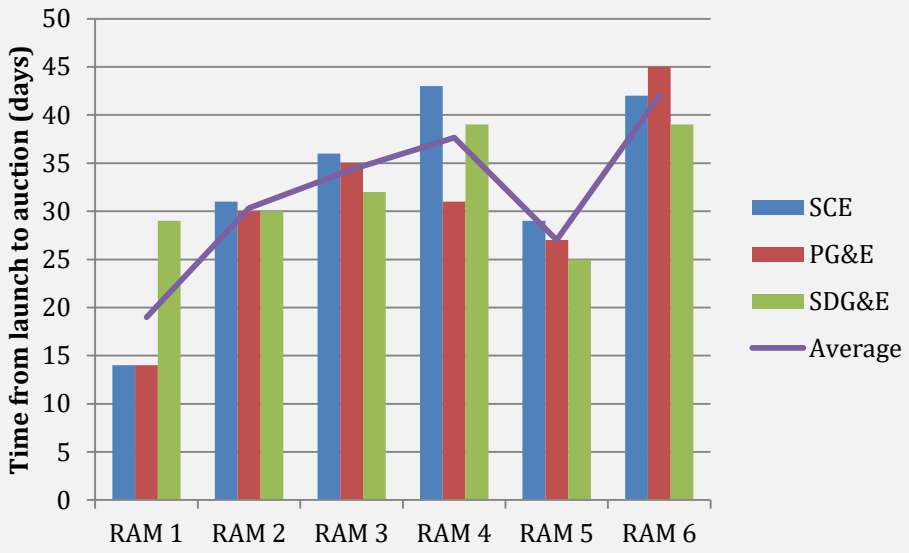
1. Characteristics of auctions in California

Table 1. Characterisation of auctions California

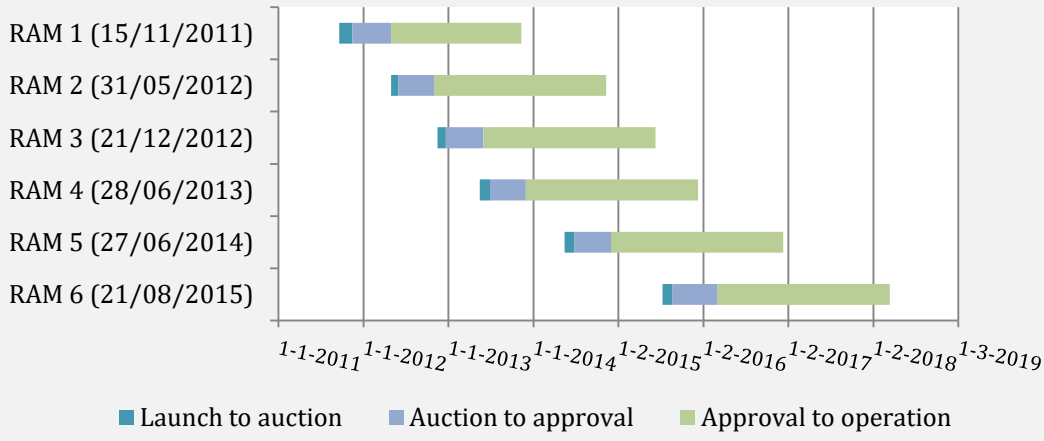
Characteristics	Description
Country characteristics	California has some of the most ambitious policies towards renewable energy in the USA. It has a Renewable Portfolio Standard (RPS) target of 33% RES-E by 2020 (CEC, 2015b). California also has an industrial policy commitment to building 20,000MW of renewable generation between 2011 and 2020 – 12,000MW of which planned to be distributed generation (DG) (Cook, 2013; Brown, 2010).
Market characteristics	California's electricity sector represents a mix of liberalised wholesale and regulated retail markets (Cook, 2013). The bulk of businesses and consumers in California purchase electricity from one of State's three largest investor owned utilities (IOUs), Pacific Gas & Electric (PG&E), Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E). These IOUs are both owner-operators of electricity generation plant and active participants in wholesale markets and account for approximately 75% of all Californian electricity sales (CEC, 2015a). They also procure significant volumes of renewable generation from independent power producers (IPPs) in annual solicitations in order to fulfil their RPS obligations. Retail prices are regulated by the California Public Utilities Commission (CPUC). Natural gas is currently the dominant fuel in Californian electricity generation accounting for over 60% of electricity generated and nearly half of electricity consumed in the state. Natural gas-fired plant also accounts for over 40 GW of California's approximately 80GW installed generation capacity. Renewables make up nearly 20% of the electricity generated and consumed. At the end of 2014, California had 21GW of renewable energy projects connected to the grid including more than 7GW of wind capacity and nearly 5GW of solar PV. There was more than 5GW of renewable distributed generation (DG) projects smaller than 20MW online and several GW pending or authorised (CEC, 2015c). California has several policies for supporting renewable energy expansion since the 1970s and there are numerous schemes including RPS and Feed-in programmes (ReMAT) for small-scale (<3MW) RES-e. The auction system is a complement to these programmes – delivering capacity that contributes to the RPS and influencing the priced offered by California's small-scale "ReMAT" feed-in-tariff. The weighted average price of the three utilities highest auction prices in the November 2011 RAM auction served as a starting price for the Feed-in-Tariff (FiT) mechanism which went on to adjust its price every two months based on deployment rate (CPUC, 2012b, 2014b; Wentz, 2014).
Name of auction	Renewable Auction Mechanism (RAM)

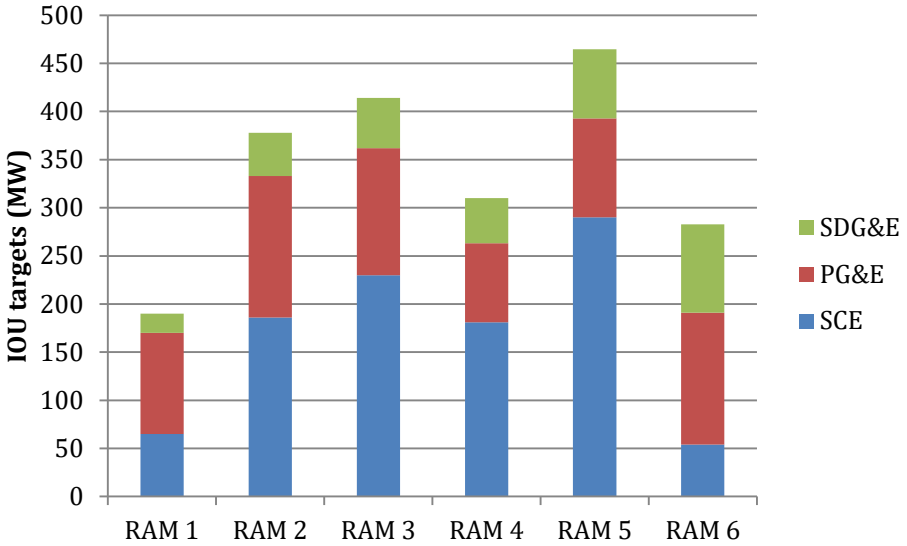
Characteristics	Description
scheme	
Objectives	The RAM was introduced to support the growth of renewable DG between 3 and 20 MW in California in support of the RPS target with smaller projects able to access the FiT and larger projects still expected to contract with utilities bilaterally under the RPS. Auctions were selected to promote competition and protect ratepayers from over-rewarding projects (Wentz, 2014). It is also a primary objective to create a system which can realise projects in a faster and more streamlined manner than the annual RPS solicitations through the use of standardised contracts (CPUC, 2012a). It targeted a certain level of technology diversity by requiring the procurement of three distinct product groups - baseload, peaking (largely solar) and non-peaking (largely wind).
Contracting authority	The three main IOUs are mandated to administer auctions and authorised by the CPUC to enter private contracts with generators. The CPUC also approves the detailed auction design ahead of each round including the PPA on offer. Following the auction, CPUC also approves the contracts and the associated cost recovery from electricity consumers. The figure below illustrates the arrangement.  *Figure 0.1: RAM institutional arrangement*
Main features	The California Public Utilities Commission (CPUC) required the three largest IOUs to procure the renewable energy generation needed to reach their RPS goals through the RAM auction programme. Running alongside the primary annual RPS solicitations and

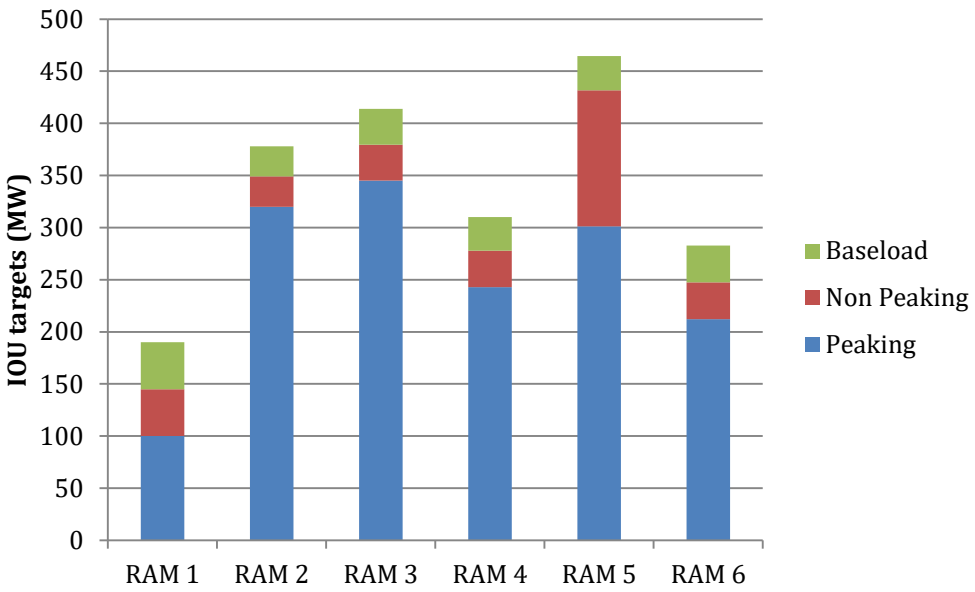
Characteristics	Description
	the ReMAT small-scale feed in tariff, the RAM is a system of static, single-criterion, auctions with some competition between technologies. All power-purchase contracts entered into by regulated utilities must be approved by the CPUC and RAM is a framework within which all of the IOUs can let legally identical, standardised power purchase agreements (PPAs).The intention is to speed up the contract process and enable rapid capacity deployment, Contracts may differ slightly from RAM to RAM as modifications are made in an open discussion between stakeholders but the RAM contracts used by the three IOUs in each RAM auction are legally identical, a feature which is appreciated by developers and their financiers. Starting in 2011, IOUs were instructed to hold auctions every six months with volumes to be contracted divided among the three entities based on market share (CPUC, 2012c). Having demonstrated the principle of auctioning standard contracts and delivering a significant increase in contracting, the RAM programme officially closed after the sixth auction on August 21st, 2015. Some features of the RAM programme will persist as an option for IOUs in the ongoing RPS procurement process, principally the standardised contracting element and product categories. Other elements such as the restriction on project sizes (3-20MW) will be optional for IOUs that choose to use RAM in future.
Year of introduction	Based on the contracting model initially developed in 2007 by California's largest utility, SCE, the RAM was proposed in 2010 and implemented in 2011. Some significant changes were implemented in 2012 following the first auction round and again following the second. The basis for the updates was open forums between IOUs and bidders (CPUC, 2012c, 2012d).
Technology focus and differentiation	The current price of solar power in California and the number of projects that can be put into development very quickly means that a technology unconstrained auction would receive an overwhelming majority of bids from solar PV which would go on to dominate the auction outcomes. In order to counter this trend, IOUs are required to procure three 'product types' and to break their overall capacity target down by product and to target at least 3MW per auction in each category (Wentz, 2014). The product types are: • '**Peaking as-available':** includes technologies with a diurnal generation profile which tends to coincide with California's substantial air-conditioning-driven afternoon load peak such as solar PV; • '**Non-peaking as available':** includes technologies with low or negative correlation with the load profile such as wind and small-scale hydro; • **'Baseload'**: includes dispatchable plant such as geothermal and biomass As part of each RAM round, each IOU must declare individual contracting targets for

Characteristics	Description
	each product category. IOUs set their own targets but they must be approved by the CPUC and are open to protest by stakeholders such as groups supporting particular technologies (for an example see California Wind Energy Association, 2014). After each RAM round, the IOUs must contract for a volume no less than 20MW below the target and no more than 20MW above the target.
Lead time before auction	The lead time between the initial announcement of the auction by publication of a request for offers (RFO)[1] and the auction itself varies. The CPUC mandates the date of the auction but in order to launch the RFO, the IOUs must seek and obtain regulatory approval for their solicitation, including the timelines and the specific wording of the PPA on offer. The time taken to achieve approval may vary but IOUs tend to begin the solicitation as soon as the auction details are approved. Lead times of the six RAM auctions varied between 2 and 6 weeks with 4 weeks typical.  *Figure 0.2: RAM lead times. (Documents available from: SCE, 2015b; PG&E, 2015b; SDG&E, 2015b)*
Min. / max. size of project	To qualify, projects must have capacity between 3 and 20 MW (CPUC, 2012a).
What is auctioned?	The IOUs offer a standardised PPA for auction. Contracts are for a fixed price per unit of production $/MWh, but do not reflect other revenues such as from tax credits. Contracts can be of various standard lengths determined by the IOUs (10, 15 or 20 years) chosen by the bidder. Bidders also define how the price evolves through the contract at yearly intervals to account for anticipated changes to their costs. In order to rank and compare

[1] The process is known as the 'solicitation'

Characteristics	Description
	bids, the present value of all bids is calculated to enable a comparison of the relative cost of the contracts to the utility, typically with a discount rate of 10%. Prices paid are adjusted according to time-of-day factors that seek to reward generation that is produced at times of peak demand more highly.
Budgetary expenditures per auction and per year	The budgetary implications of RAM were expected to be negative since IOUs would have to procure the capacity to meet their RPS obligations in any case and RAM was expected to allow them to do it at lower cost. Overall, the RAM programme sought to procure 1,300MW of renewable energy capacity. To put this volume in context, as part of California's 2020 RPS target of 33% of electricity from RES, it has an industrial target to build 12,000MW of renewable DG between 2010 and 2020 under the 'Clean Energy Jobs Plan' (Brown, 2010). RAM, therefore, represents about 10% of California's 2010-2020 renewable DG ambition.
Frequency of auctions	The original RAM plan was to conduct four auctions at six-monthly intervals to procure the desired capacity. However, two subsequent auctions have been held in order to reach the achieved volume of contracting. The figure below shows the timelines of the six RAM auctions.  *Figure 0.3: RAM timelines (Documents available from: SCE, 2015b; PG&E, 2015b; SDG&E, 2015b)*
Volume of the tender	Originally a 1,000 MW capacity limit was set for the entire programme, distributed among the three IOUs based on market share. Subsequently, two of the utilities transferred some solar capacity from another programme increased the programme's cap to 1,300 MW (Wentz, 2014). The final capacity allocations are shown below: Utility — Total Procurement Requirement Southern California Edison — 723.4 MW Pacific Gas and Electric — 420.9 MW

Characteristics	Description
	San Diego Gas and Electric 154.7 MW *Table 0-1: RAM capacity allocation by utility (CPUC, 2014a)* Awards of 25% of the IOUs' requirement were intended for each auction, requiring 4 auction rounds in total. In addition to the volume mandated by CPUC, the utilities were able to increase the volume of offers 2 through 6 in order to account for volume contracted in earlier rounds but lost to project failure or contract termination, leading to a fairly uneven utility-set procurement targets. A fifth and sixth auction were authorised and held in 2014 and 2015 to complete the contracting of up to 1,300MW of capacity. The procurement target set by the utilities in their request for offers (RFO) for each of the RAM rounds is shown below, broken down by utility. Across the six rounds, offers were made of just over 2,000MW.  *Figure 0.4: RFO targets by IOU (Documents available from: SCE, 2015b; PG&E, 2015b; SDG&E, 2015b)*

Characteristics	Description
	 *Figure 0.5: RFO targets by technology group (Documents available from: SCE, 2015b; PG&E, 2015b; SDG&E, 2015b)*
Auction design elements	See Table 2

Design elements for the assessment of auction schemes for RES-E

Table 2. Design elements for the assessment of auction schemes for RES-E

Design elements	
Single- or multiple-item auctions	Multiple-item auction – as many bids as needed are selected up to the utilities' product-group procurement targets.
Auction procedure	The auction process itself is organised as static auctions (so called "sealed bid"). In this option, bidders have no information on other bids and thus cannot react to those.
Pricing rules	Sealed-bid (static) auction. Offers are ranked according to present value of the contract including estimates of required transmission system upgrades and any possible resource adequacy benefits. Bids are ranked in the three product categories (peaking, non-peaking and baseload) with the IOUs required to propose individual targets for each category that must be agreed by CPUC. IOUs must procure ± 20MW of each target. The procedure for

Design elements	
	moving from auction announcement to close is show below:

Schedule	Action
0	Utility submits plan for auction including details of standard PPA
~ 12-14 weeks	CPUC approves auction plan
~ 1-2 weeks	Utility launches auction and releases all details
~ 1 week	Utility holds web conference to answer any queries
~ 5weeks	Auction deadline
~ 10 weeks	Utility advises bidders of status – award, rejection or waitlist
~ 2 weeks	Awarded bidders must return signed PPA
~ 1 week	Waitlisted bidders advised of status
~ 2 weeks	Waitlisted bidders must submit signed PPA
~ 2 weeks	Execution of PPAs by utility
~ 6-7 weeks	Utility submits all executed PPAs to CPUC for final approval

To minimise the impact on target achievement of projects unable to proceed due to unrealistic pricing in the non-binding auction, a system of exhaustive reallocation is implemented. At the time of ranking the projects, each IOU draws up a 'waitlist' of 'second-best' projects representing up to 50% of targeted capacity. When presented with the irrevocable PPA, projects that drop out are replaced in the ranking from the waitlist and duly presented with an opportunity to sign a PPA at their contract price.

The regularity of auctions and the clarity of intent (targets set for the entire purchasing programme) demonstrated by the CPUC is likely a factor in the very high participation levels experienced by the programme with a large volume of projects set in motion to exploit the opportunity.

Ceiling price	No ceiling price is set.
Qualification criteria	A number of qualification criteria (known as viability criteria) are stipulated by CSUC, primarily to ensure project viability and prevent speculative participation (CPUC, 2012a). These are: Site control: Bidders must be able to demonstrate 100% site control through ownership, lease or option;

Design elements	
	Experience: At least one member of the development team has completed or progressed to the construction phase at least one project of similar technology and capacity; Technology: Only projects based on generation technology of which are at least two examples operating commercially worldwide; Interconnection Study: In order to participate, a project must have undertaken and received the results of an interconnection study making it clear that the connection is viable. From RAM 4 onwards an offer confirming connection within the time allowed for development was required.
Penalties	The target operational date used as the basis of the pre-qualification assessment for the projects participating in RAM was 18 months from a regulator approved contract for RAM 1, 24 months for RAM 2-5 and 36 months for RAM 6 (CPUC, 2012c).Two types of penalties are imposed in the form of deposits which may be withheld under various circumstances. A deposit is required to ensure project delivery (project development deposit) and continued satisfactory operation of the plant (performance deposit). Deposits are placed with the utility on execution of the PPA. **Development deposit** A $20 / kW (€17.7 / kWh) deposit is required and forfeited in the case of project non-delivery and returned either once the project enters operation or combined with the performance deposit. **Performance deposit** • Projects <5MW: equal to the development deposit - $20 / kW (€17.7 / kWh) • All other projects: 5% of expected lifetime revenues of the project.
Monitoring of realisation progress	The IOUs monitor project progress and are required to submit ex-post reports to CPUC on each auction which include the status of contracted projects and the time taken to realise successful projects (CPUC, 2012a).
Exceptions from requirements for small plants/developers?	Participation in the programme is voluntary with other schemes available in parallel such as the REMAT feed-in tariff. All participating projects and developers treated equally.
Support auctioned	The CPUC specifies the target(s) in capacity terms and the IOUs tender for a specific number of MW. The ranking of bids to determine auction winners is the present value of

Design elements	
	the contract's lifetime revenue requirement, reflecting the bidder's expectation of changes to their costs across time and adjusted first to reflect an estimate of the required transmission system upgrades and secondly to acknowledge the project's 'resource adequacy benefits ' to the IOU.
Transferability of support right	Transferability arrangements are defined in the offered PPA. The PG&E PPA, for example, allows for transfer with the consent of the utility which cannot withhold consent unreasonably (e.g. PG&E, 2011, 10.6).

2. Evaluation criteria for the assessment of auction schemes for RES-E

Actor variety and social acceptability

An important element of the RAM is the regular interaction between the CPUC, IOUs, developers and other stakeholders. This interaction seems to be a key element in producing a policy for which there is genuine and broad support from participants. The IOUs webinars at the launch of each RAM auction are well attended and deemed useful.

Actor diversity

In the first five auctions, a large number of actors had participated in the RAM programme with 1,391 bids placed by 161 individual entities across all three IOUs representing over 20GW of renewable capacity (PG&E, 2015a; SDG&E, 2015a; SCE, 2015a). No data were collected by the IOUs on the size or type of actor but it is possible to make some tentative assessments.

Despite access to the RAM being limited to bidders with demonstrable experience, a wide range of actor types participated in the RAM. Actors submitting bids included specialist renewable developers, development arms of large international utility companies and oil majors as well as some local government agencies. A less diverse population of actors was successful in the process. Altogether, by February 2015, just over 50 actors had succeeded in reaching the contracting stage of the procurement process, nearly all of which are large specialist development companies. The figure below shows the breakdown of bid and winning capacity by number of actors. The number of actors reaching the contracting stage increased following the fairly low number of winners in the first round. It is interesting to note that the pre-qualification criteria explicitly exclude new or inexperienced actors.

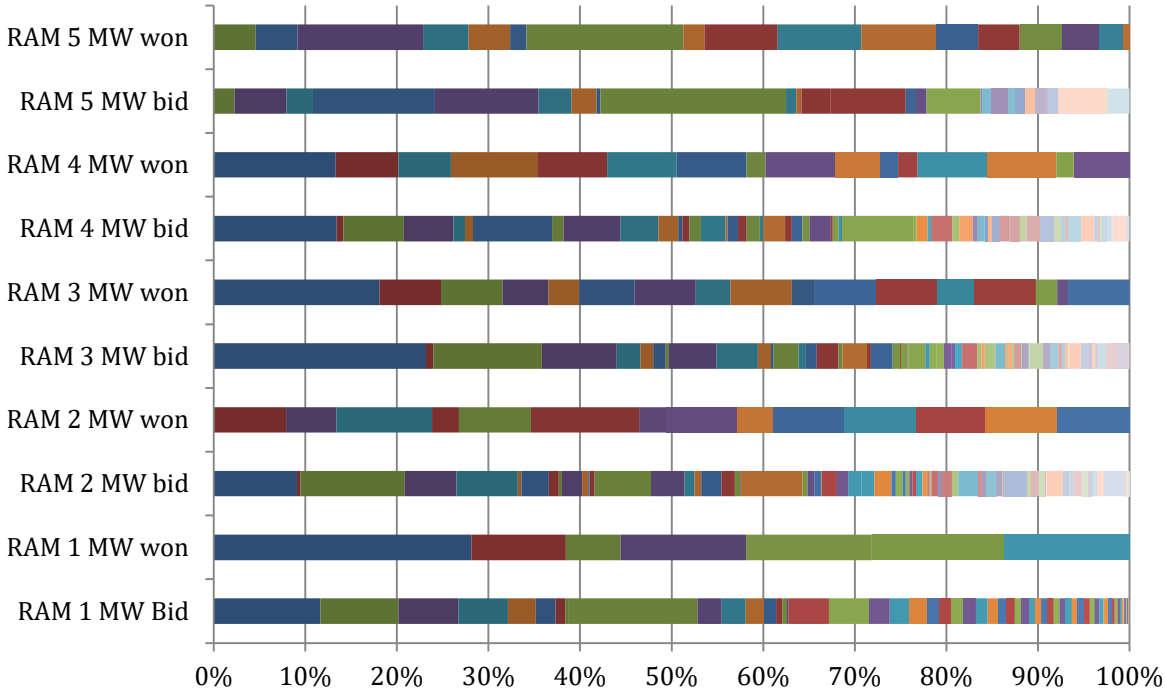


Figure 0.1: Participation (coloured bands denote capacity bid/won by each participant)

	Bidders	*Winners*
RAM 1	58	7
RAM 2	76	14
RAM 3	61	17
RAM 4	61	16
RAM 5	28	17

Table 0-1: Bidders and winners

Project size diversity

The RAM penalties are explicitly structured to encourage smaller projects (between 3MW and 5MW) to participate. Nevertheless, approximately half of all projects bid and won were the maximum permissible size, reflecting the returns to scale of power generation projects. Despite the preference for the largest projects in the size category, the average size would clearly have been larger if there was no upper limit to the size of project that could participate.

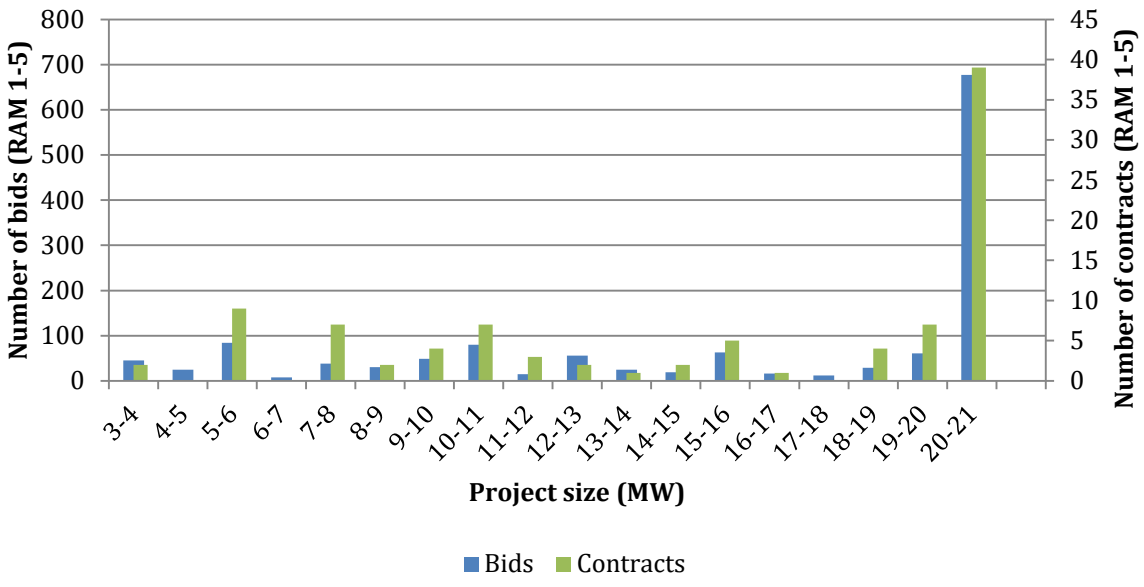


Figure 0.2: Participation by project size

The tendency for larger projects to succeed in the auctions was greater for the most successful technologies, solar PV and wind.

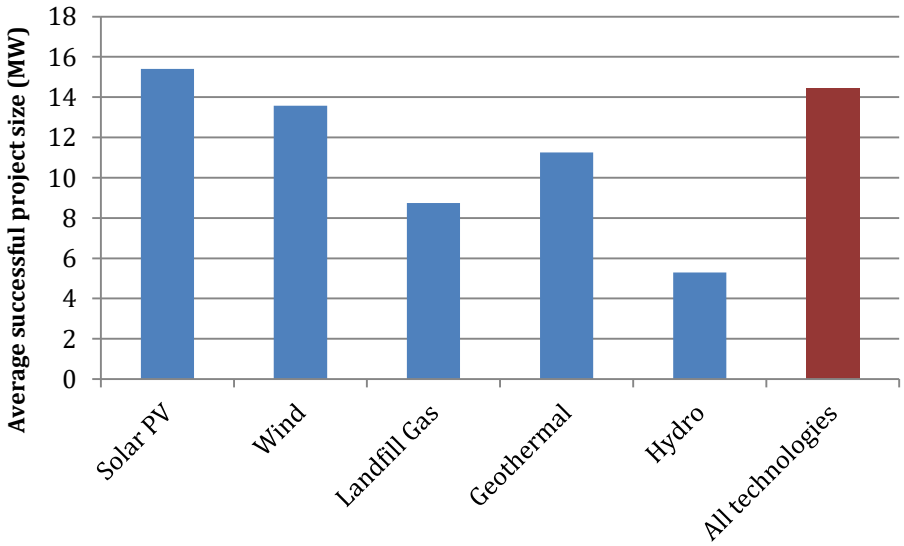


Figure 3.3: Average successful project size by technology, RAM 1-5

Policy effectiveness (effectiveness of auctions)

The main objective of the RAM policy was to deliver a rapid boost towards California's RPS target, which was expanded in 2011. The policy specifically targets renewable DG. There were several distinct policy goals:

i) rapidly realise up to 1,300MW of renewable DG;
ii) reduce the time, complexity and cost of utilities and generators contracting to build renewable generation;

iii) promote a range of RES technologies;
iv) and minimise the cost of achieving the other goals.

Target achievement

The policy target is framed as the volume of contracted generation, rather than realised or operational generation.

Contracting rate

The goal of 1,300 MW of contracted generation is likely to be reached. In February 2015 more than 1,400MW was contracted, almost 1,200 MW of which was still declared by the utilities as 'online', 'on schedule' or 'delayed'[2]. Nevertheless, the contracting rate for all auctions was lower than expected, leading to two more auctions that originally anticipated (RAM 5&6).

The table below shows the volumes solicited by the IOUs in each auction and the volume of contracting achieved. The ability to move un-contracted volume from one auction to the next and some apparently mutual learning by both the IOUs and the IPP market lead to a steady improvement in contracted generation.

	RAM 1	RAM 2	RAM 3	RAM 4	RAM 5
MW targeted by IOUs	190	378	414	310	465
MW contracted	146	254	298	263	458
Success rate	77%	67%	72%	85%	98%

Table 0-2: Solicited and contracted RES DG RAM 1-5

Realisation rate

While not an explicit goal of the RAM programme, the realisation rate of projects is a useful measure of the ability of a programme to realise real, generating projects. The complexity and risk of financing and building renewables projects mean that some projects will inevitably fail before becoming operational. In the case of RAM, developers that 'drop out' of the process after the PPA has been executed will lose their deposit.

In February 2015, only RAM 1&2 had passed the point by which most contracted projects could be expected to be online and generating. The table below presents their status.

Status in Feb '15	MW	%
Online	239	60%
On Schedule	54	13%
Delayed	40	10%
Terminated	67	17%

Table 0-3: Status in Feb. '15 of projects contracted in RAM 1&2

[2] i.e. not 'terminated'

Nearly three quarters of projects are online or 'on schedule' probably implying that the eventual realisation rate will be somewhat higher than 60% of the total contracted volume. Indeed, even if all delayed projects are terminated (and there is no reason to believe they should), a realisation rate of 74% is possible.

A fast track system

The attempt to create a system which is faster from solicitation to contract has been a success. While the RPS solicitations take at least a year of effort by all parties to reach a regulator-approved contract, the RAM system can move from launch to executed contract in as little as 6-8 months.

A range of technologies

It was a stated aim of the RAM to promote a range of RES technologies. However, the flexibility given to the IOUs to set their own targets when soliciting for the three product groups led to a significant weighting in favour of solar PV before bidding even began. The relatively low cost and rapidity with which a solar PV project can be established means that this is not necessarily an adverse outcome but it does mean that whatever the outcome of the auctions, solar PV was always going to be prominent. The auction could not avoid a further concentration of solar PV as the utilities seek make use of the +-20MW flexibility to minimise their obligation to procure non-PV technology. No pronounced difference in contract termination rates is observed between technologies.

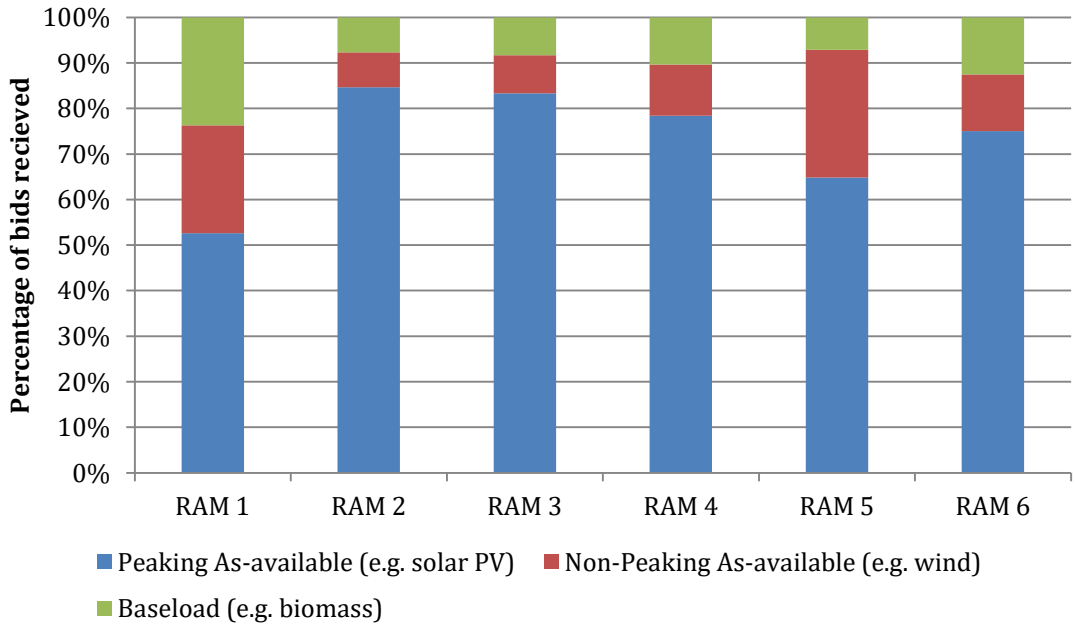


Figure 0.3: Solicitation of different technology groups (RFOs available from: SCE, 2015b; PG&E, 2015b; SDG&E, 2015b)

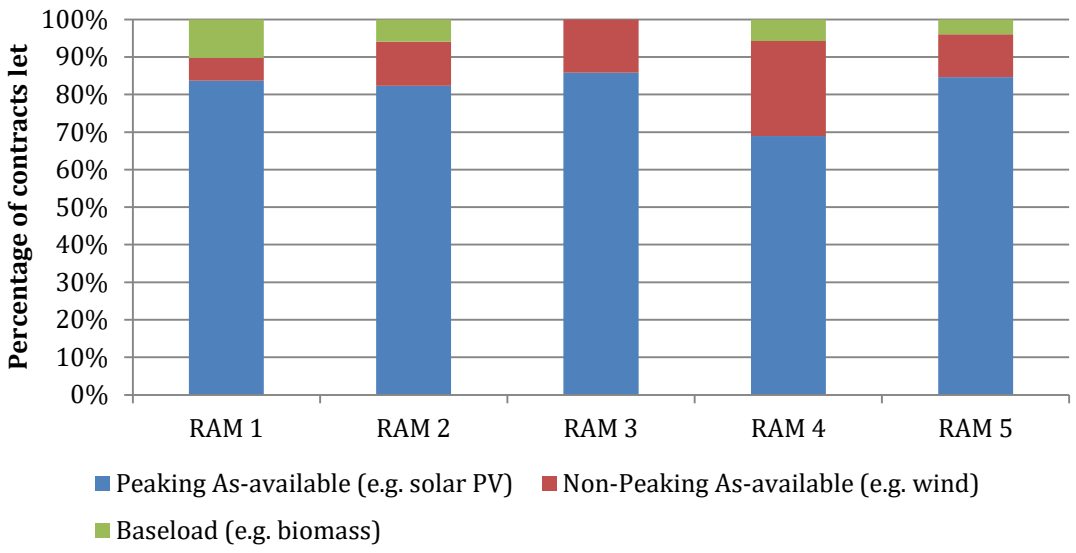


Figure 0.4: Contracting of different technology groups (RFOs available from: SCE, 2015b; PG&E, 2015b; SDG&E, 2015b)

Static efficiency or cost effectiveness (including transaction and administrative costs)

The RAM programme is seen by its administrators, CPUC, as achieving low cost deployment. CPUC reports that average RAM contract prices across all utilities fell across the first three rounds from $90 / MWh (€79.5 / MWh) in RAM 1 to $88.75 / MWh (€78.4 / MWh) in RAM 2 and $79.82 / MWh (€70.5 / MWh) in RAM 3 (CPUC, 2014a). This is attributed to the very large interest in the programme with an approximately 10:1 bid to contract ratio (CPUC, 2014a) and more than 20 GW bid in the first five auctions[3]. It is difficult to assess whether the contract prices are low in an international context since the prices reported do not reflect major policy factors such as a solar's 30% investment tax credit (ITC) and wind's $23 / MWh (€20.3 / MWh) production tax credit[4]. According to accounts from developers, utilities and the regulator, the transaction and administrative costs were markedly reduced compared with the direct alternative, the RPS solicitation route.

[3] May reflect some duplication as bidders are able to submit bids for the same project to more than one utility (or the same utility both with and without resource adequacy benefits)

[4] Only available to projects started before December 31st 2014

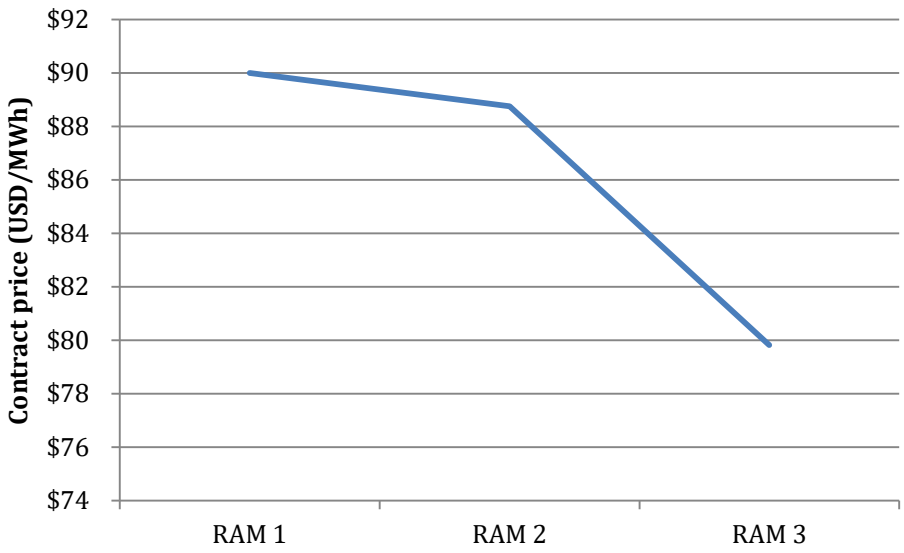


Figure 0.5: Average contract prices, RAM 1-3 (CPUC, 2014a)

Dynamic efficiency

The auction programme did not elicit bids from immature or novel technologies and, as noted, was dominated by solar PV, a technology for which the global market is large enough to be unaffected by a gigawatt or so of contracting in California. Some concession is made for smaller (3 to 5 MW) projects in the penalty structure.

Compatibility with market principles and integration

Renewables procurement on a PPA basis does not lend itself well to wholesale market integration, being more or less the same remuneration structure as a fixed feed- in tariff. A single transaction concludes the PPA and, once operating, the IPP-owned plant does not participate in wholesale power markets. Nevertheless, operators are encouraged to reflect some market-issues in their operational behaviour through pricing adjustment factors in the standard RAM PPA which pay higher prices at times of highest system demand. The contract does not, however, refer to the wholesale market or any other external factors.

Distributional effects & minimisation of support costs

As a means of reducing the cost of contracting for renewables by California's IOUs, the RAM is generally regarded as a success. Without an international comparison or any pricing information available for non-RAM contracts a more detailed analysis is not possible but it is likely that RAM has, overall, reduced producer surplus in the Californian renewable IPP market.

Distribution of support costs across society for RES in California is hard to attribute. Some of the cost is borne through the PPA pricing structure to be passed onto Californian electricity consumers and some onto US tax payers through the tax credit support. A methodology is currently unavailable for exploring the distribution of RES costs among different societal actors.

3. Lessons learnt: key best practices and pitfalls identified

Good project realisation rates, low transaction costs and reportedly low outturn prices all suggest that the RAM programme can be seen as largely successful. But the success is not unalloyed. Contracting rates were lower than predicted in the first four rounds - requiring two additional auctions - and technology diversity was poor, despite being a policy goal. Dynamic efficiency was not targeted. And, within the size range targeted by the programme, large projects were over-represented in both bidders and winners. Several lessons of general relevance can be taken from California's experience:

Visibility of more than one instance of an auction is likely to increase developer appetite

The visibility of the upcoming rounds on more or less fixed dates (every six months) and for pre-determined volumes enabled the supply chain to plan for participation and develop projects to suit the RAM programme, adding to the very high developer interest in the programme.

Engagement with stakeholders fosters support and participation

An open dialogue with stakeholders, from considered responses to queries about even minor details, is a central feature of regulatory decision making in California. In the case of RAM, it does appear to have engendered broad support for the programme. Stakeholders' points appear to have been taken seriously and resulted in changes to the policy (see any CPUC decision, such as CPUC, 2014a). Whether the decision-making process is equally open to all stakeholders and whether the same level of potential influence over policy is afforded to all actors are both questions for further research.

Strict pre-qualification criteria are a trade-off

Qualification criteria used to manage access to the RAM programme appear to have successfully helped with the achievement of the full volume of targeted contracts (albeit two auctions late) and large proportion of that volume is likely to reach operation. But the fact that the RAM was a relatively minor component in the Californian renewable scene meant that there was an extremely large pool of projects from which utilities could draw. Other jurisdictions may not have the same luxury. Also, the actor diversity was explicitly limited to large or experienced developers, which may or may not be coherent with the policy goals of all policymakers.

Auctions are not the only game in town

In California, auctions have been shown to successfully complement a quota system, tax credits and feed-in tariffs. Even within the RAM itself the reverse auction component was secondary in many ways to the novel fast-track contracting process. The potential for using auctions to complement other policy approaches (and vice-versa) should be considered.

The waitlist system screened underbid projects – but at what cost?

A waitlist system by which winning developers unable to progress to contract signing and final investment decision[5] are replaced by second-best projects does seem to mitigate the common auction problem of bidding unviable prices. But not all policymakers will have the same volume of bids from which to make selections and the strategic bidding implications of this approach are not yet understood and should be explored.

What is auctioned can be as important as how it is auctioned

The auctioneer's lot in the RAM was a standardised PPA which was previously absent from the market. This streamlined contracting approach was intrinsic to the goals and design of the programme and was seen by market participants to be an extremely important component of the RAM's success. In this context, the hard-won experience of European policy makers in designing and implementing remuneration mechanisms remains as relevant to successful RES policy as the price-setting element of auctions.

[5] Nearly always due to inability to raise finance

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