EIM Greenhouse Gas Enhancement Draft Final Proposal
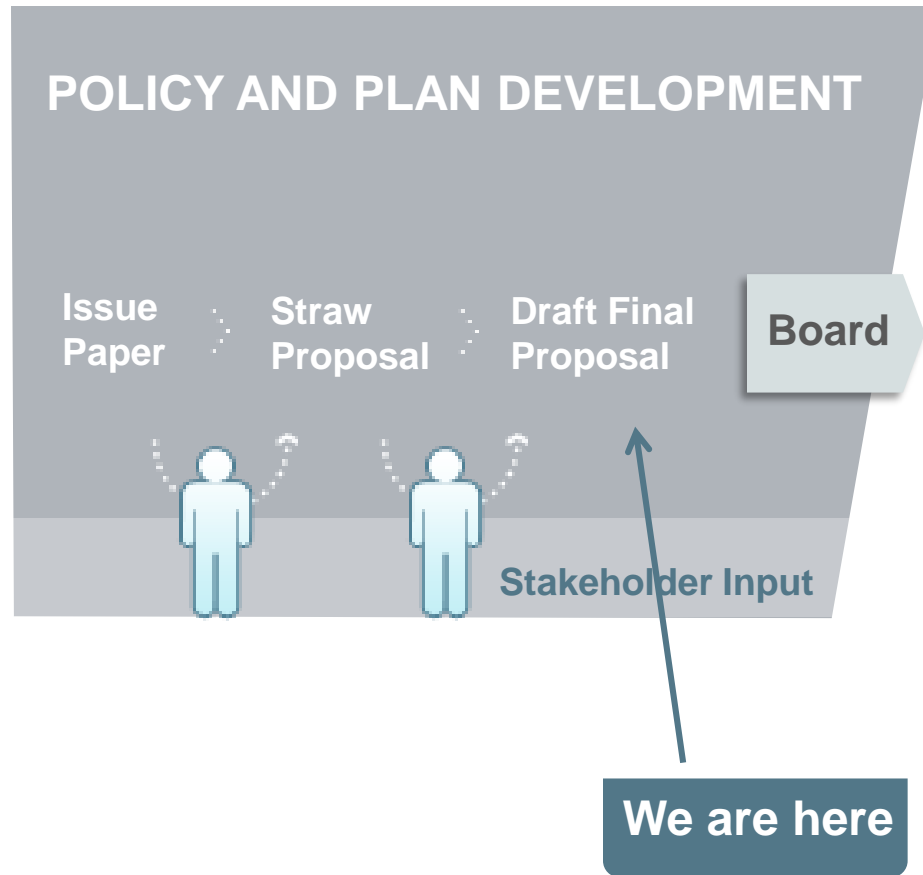
Stakeholder Meeting

May 31, 2017
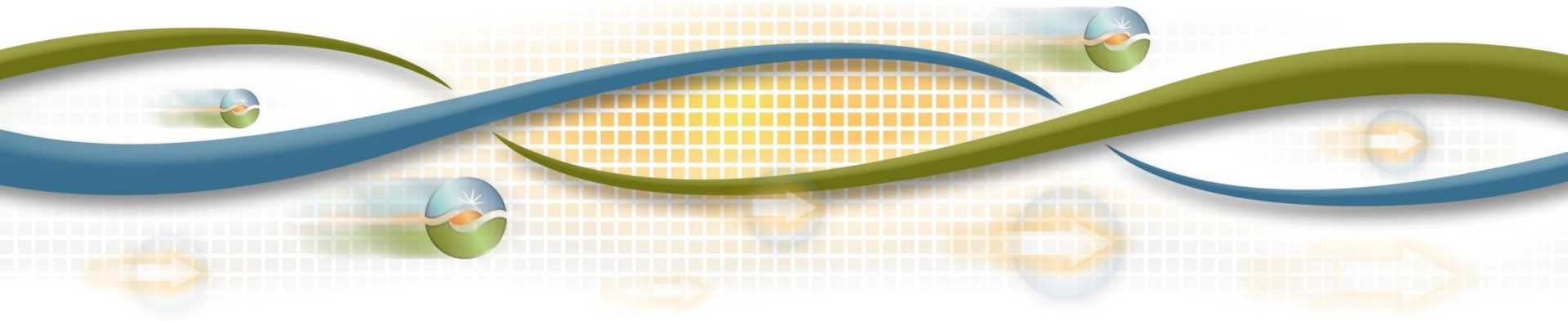
Agenda

Time	Topic	Presenter
10:00 – 10:10	Introduction	Kristina Osborne
10:10 – 12:00	Proposed GHG Market Design Changes	Don Tretheway
12:00 – 1:00	Lunch	
1:00 – 2:50	Proposed GHG Market Design Changes	Don Tretheway
2:50 – 3:00	Next Steps	Kristina Osborne

California ISO

ISO Policy Initiative Stakeholder Process

POLICY AND PLAN DEVELOPMENT

Issue Paper ⋯ **Straw Proposal** ⋯ **Draft Final Proposal**

Board

Stakeholder Input

We are here

ISO planning to implement only necessary changes in the real-time market to support EIM at this time

- Currently developing software enhancements to perform two pass solution

- Will brief EIM Governing Body and ISO Board of Governors in July

- Prepare report end of year evaluating the accuracy of the two pass solution

- Seek EIM Governing Body and ISO Board of Governors in Q1'18

- Activate software in January 1, 2019

GHG design enhancements are applicable to both the EIM and regional integration

- Concerns raised by California Air Resources Board (ARB) regarding attribution of EIM transfers pertains to EIM design as well as regional integration
  - Requires determining "California" supply when running first pass
    - "California" supply includes generators located in California, imports and EIM participating resources contracted to California load

- Regional integration will extend the enhanced GHG design to day-ahead market
  - The two pass solution can be more easily implemented in the day-ahead market

Additional design enhancements under regionalization

- Imports/Exports of multi-state balancing authority are not part a given state's GHG regime
    - Always bid a separate GHG bid

- Convergence bids in the state GHG regime where the node is located
    - Do not bid a separate GHG bid.

Design changes from straw proposal

- "California" supply is a biddable parameter

- Discuss treatment of "California" supply in optimization

All of these can contribute to optimal dispatch across the EIM footprint

1. EIM BAA load

2. EIM non-participating resources

3. EIM participating resources w/o a GHG bid

4. EIM participating resources w/ GHG

5. ISO load

6. ISO resources

California ISO

The EIM extends ISO's real-time market to other balancing authority areas

- EIM re-dispatches all resources in the combined ISO and EIM entity BAA footprint

- Current market optimization balances total supply and total demand, not incremental changes

- Market optimization minimizes total production cost while resolving congestion
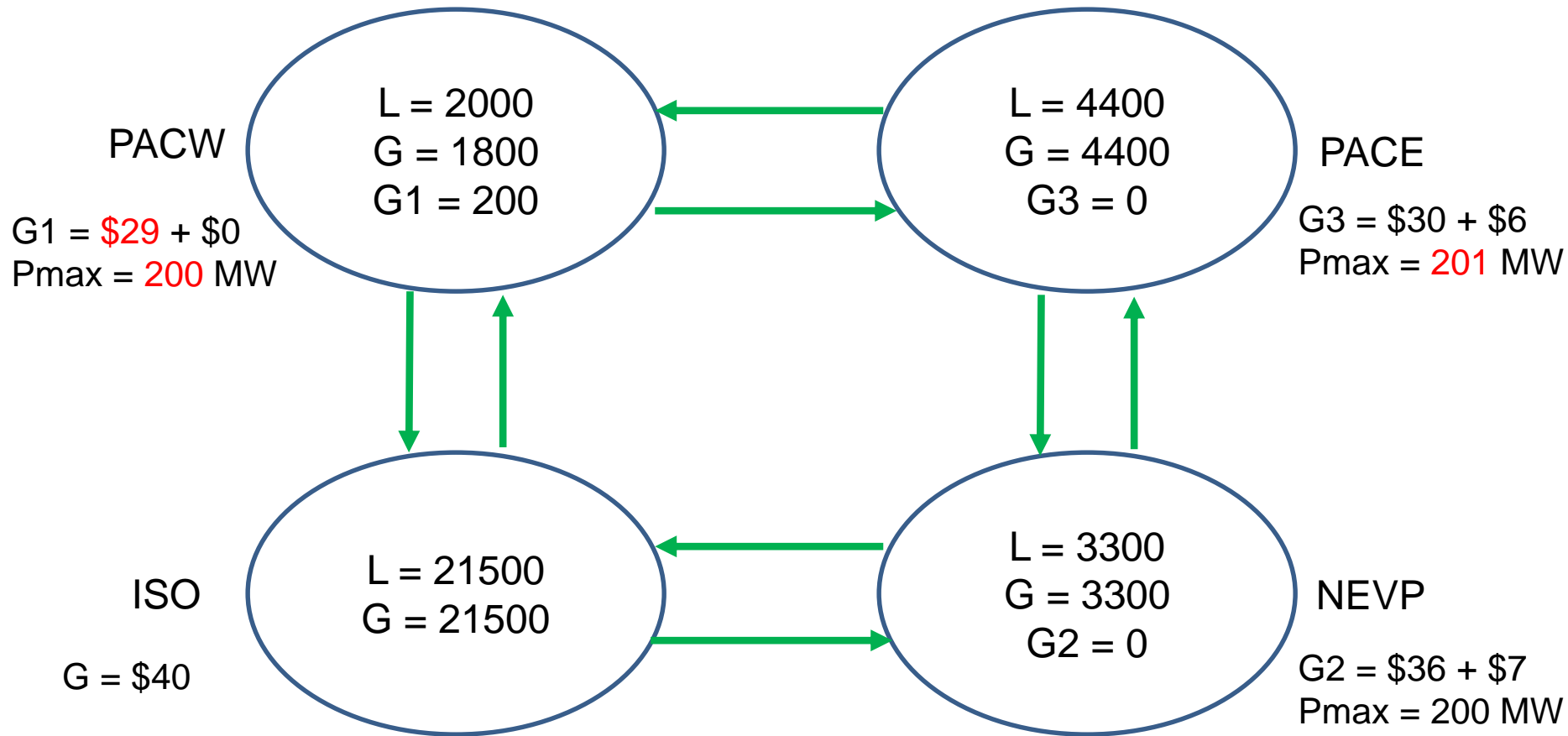
Observations of EIM dispatch optimization

- Least cost dispatch can have effect of sending low emitting resources to ISO, while not accounting for secondary dispatch of other resources to serve external demand

- Least cost dispatch can result in avoided curtailment of ISO renewables by displacing emitting resources to serve external demand

ISO is working with ARB to address concern with whether GHG attribution captures the atmospheric effects of EIM least cost dispatch

Atmospheric effect is not always apparent when GHG attributed to a base schedule

- If the attributed resource would have generated anyways, then another resource's emissions may be higher

- But, if the attributed resource would not have generated to serve non-ISO demand, then the resource's emissions are correct atmospheric effect.

California ISO

Base assumptions for example to show allocation to base schedule not aligned with atmospheric effect

PACW

L = 2000
G = 1800
G1 = 200

G1 = $29 + $0
Pmax = 200 MW

PACE

L = 4400
G = 4400
G3 = 0

G3 = $30 + $6
Pmax = 201 MW

ISO

L = 21500
G = 21500

G = $40

NEVP

L = 3300
G = 3300
G2 = 0

G2 = $36 + $7
Pmax = 200 MW

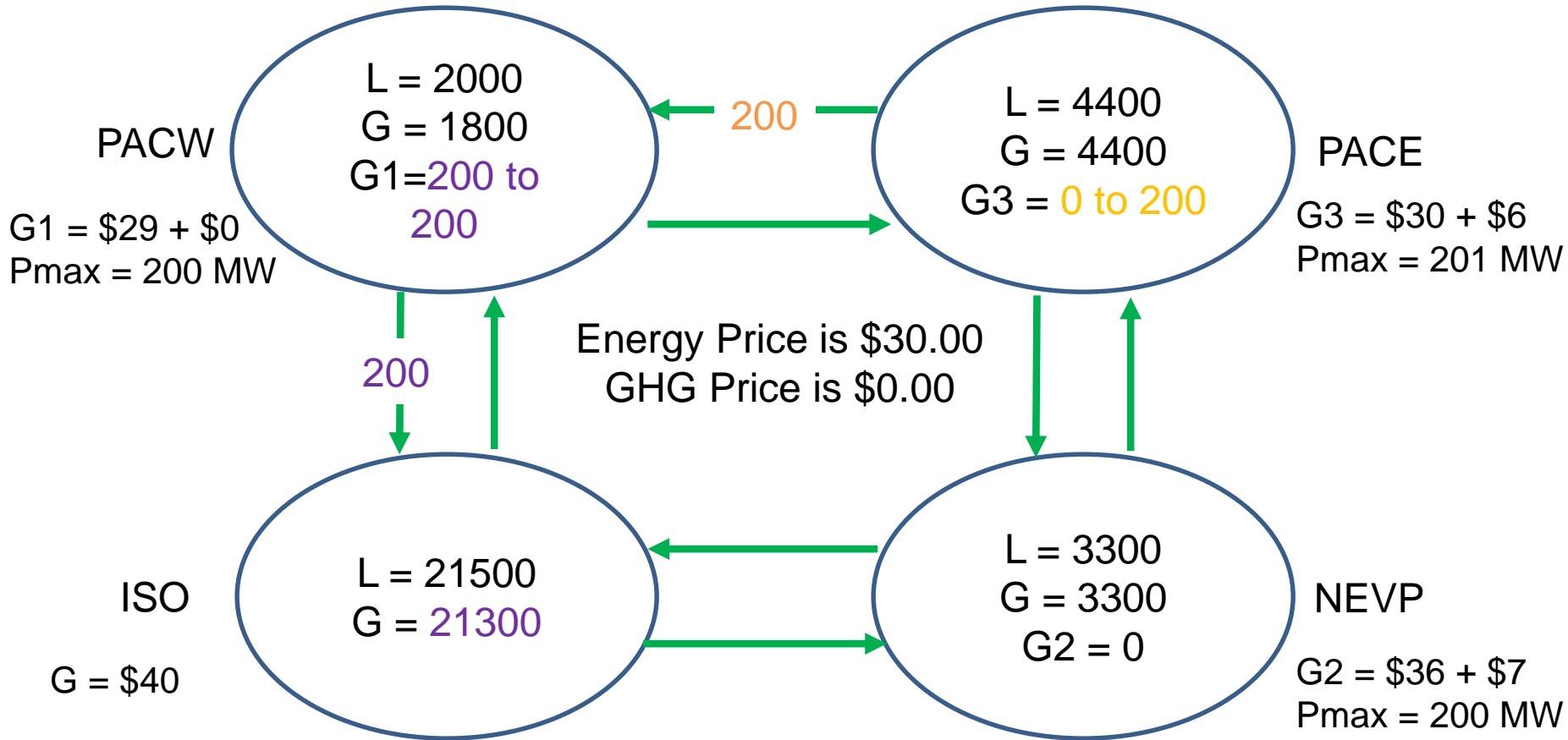Maximum reduction in ISO supply is 200 MW

EIM Generator = Energy Bid + GHG Bid

G1-G3 PMin 0 MW
GHG MW for all is 200 MW
Transfer limit into ISO is 201 MW
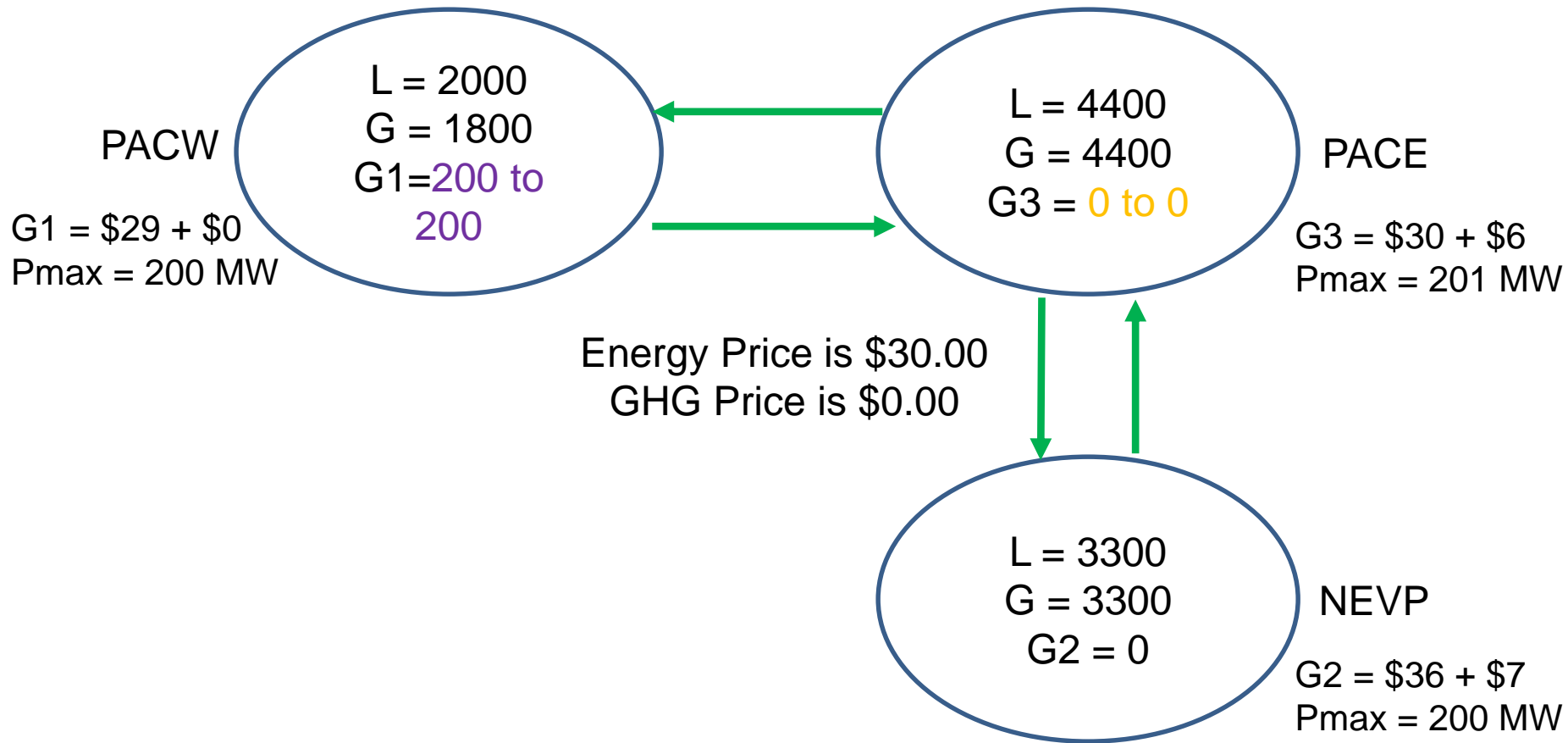
California ISO

Let's solve the market for the EIM footprint

PACW

L = 2000
G = 1800
G1=200 to 200

G1 = $29 + $0
Pmax = 200 MW

200

PACE

L = 4400
G = 4400
G3 = 0 to 200

G3 = $30 + $6
Pmax = 201 MW

200

Energy Price is $30.00
GHG Price is $0.00

ISO

L = 21500
G = 21300

G = $40

NEVP

L = 3300
G = 3300
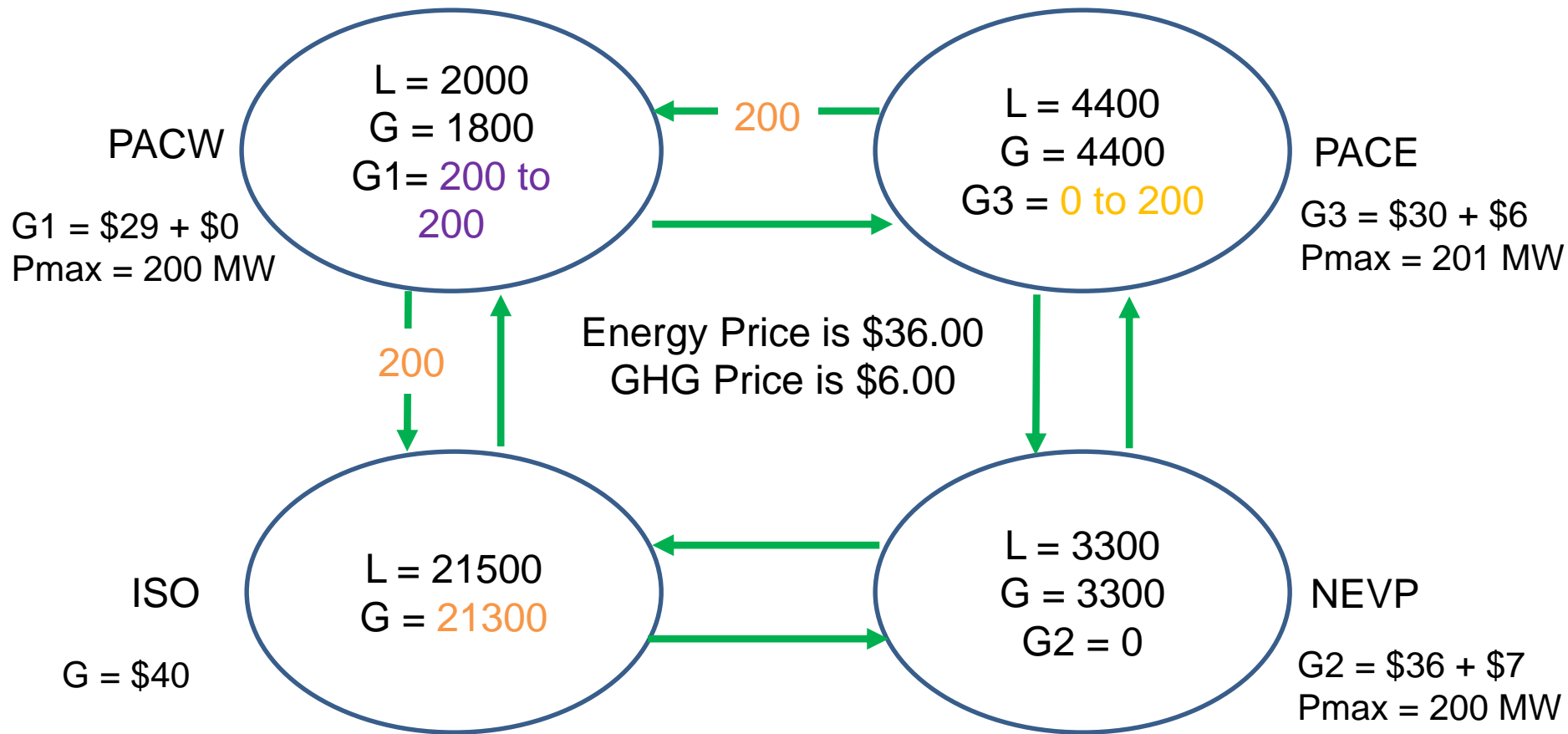**G2 = 0**

G2 = $36 + $7
Pmax = 200 MW

Is this an example of "secondary dispatch" because the base schedule of G1 is attributed to ISO?

California ISO

Now let's assume the EIM entities optimized their base schedules before including the ISO

PACW

L = 2000
G = 1800
G1 = 200 to 200

G1 = $29 + $0
Pmax = 200 MW

PACE

L = 4400
G = 4400
G3 = 0 to 0

G3 = $30 + $6
Pmax = 201 MW

Energy Price is $30.00
GHG Price is $0.00

NEVP

L = 3300
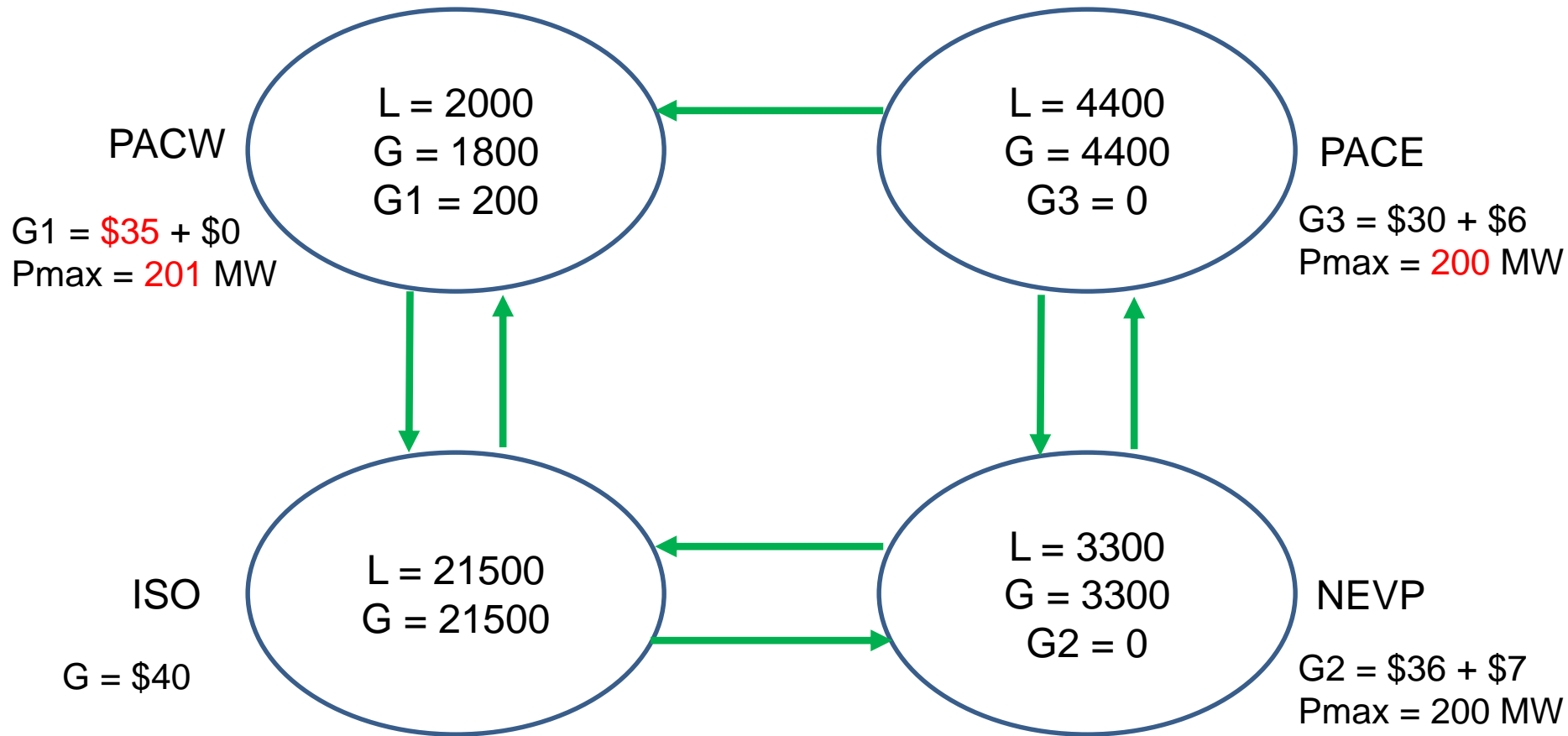G = 3300
G2 = 0

G2 = $36 + $7
Pmax = 200 MW

There is no re-dispatch because the base schedules are optimal.

California ISO

Now let's optimize from the prior slide's starting point and include the ISO

PACW

L = 2000
G = 1800
G1 = 200 to 200

G1 = $29 + $0
Pmax = 200 MW

← 200 —

PACE

L = 4400
G = 4400
G3 = 0 to 200

G3 = $30 + $6
Pmax = 201 MW

Energy Price is $36.00
GHG Price is $6.00

200

ISO

L = 21500
G = 21300

G = $40

NEVP

L = 3300
G = 3300
G2 = 0

G2 = $36 + $7
Pmax = 200 MW

The current EIM design would not reflect the $6.00 GHG cost of G3

LMP inside ISO is $36. LMP outside ISO is $30.

California ISO

Base assumptions for example to show allocation to base schedule correctly reflect atmospheric effect

PACW

$$L = 2000$$
$$G = 1800$$
$$G1 = 200$$

G1 = $35 + $0
Pmax = 201 MW

$$L = 4400$$
$$G = 4400$$
$$G3 = 0$$

PACE

G3 = $30 + $6
Pmax = 200 MW

ISO

$$L = 21500$$
$$G = 21500$$

G = $40

$$L = 3300$$
$$G = 3300$$
$$G2 = 0$$

NEVP

G2 = $36 + $7
Pmax = 200 MW

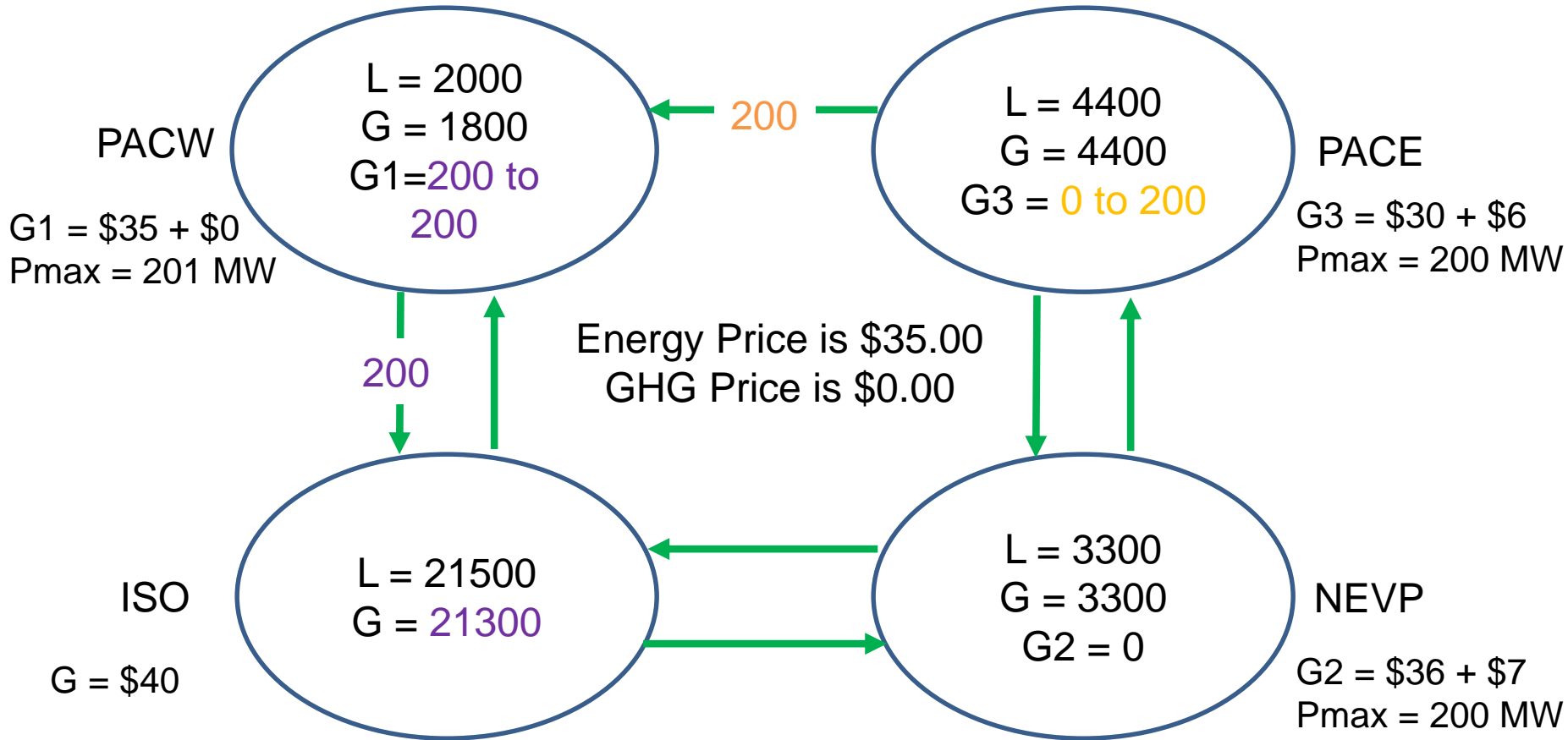Maximum reduction in ISO supply is 200 MW

EIM Generator = Energy Bid + GHG Bid
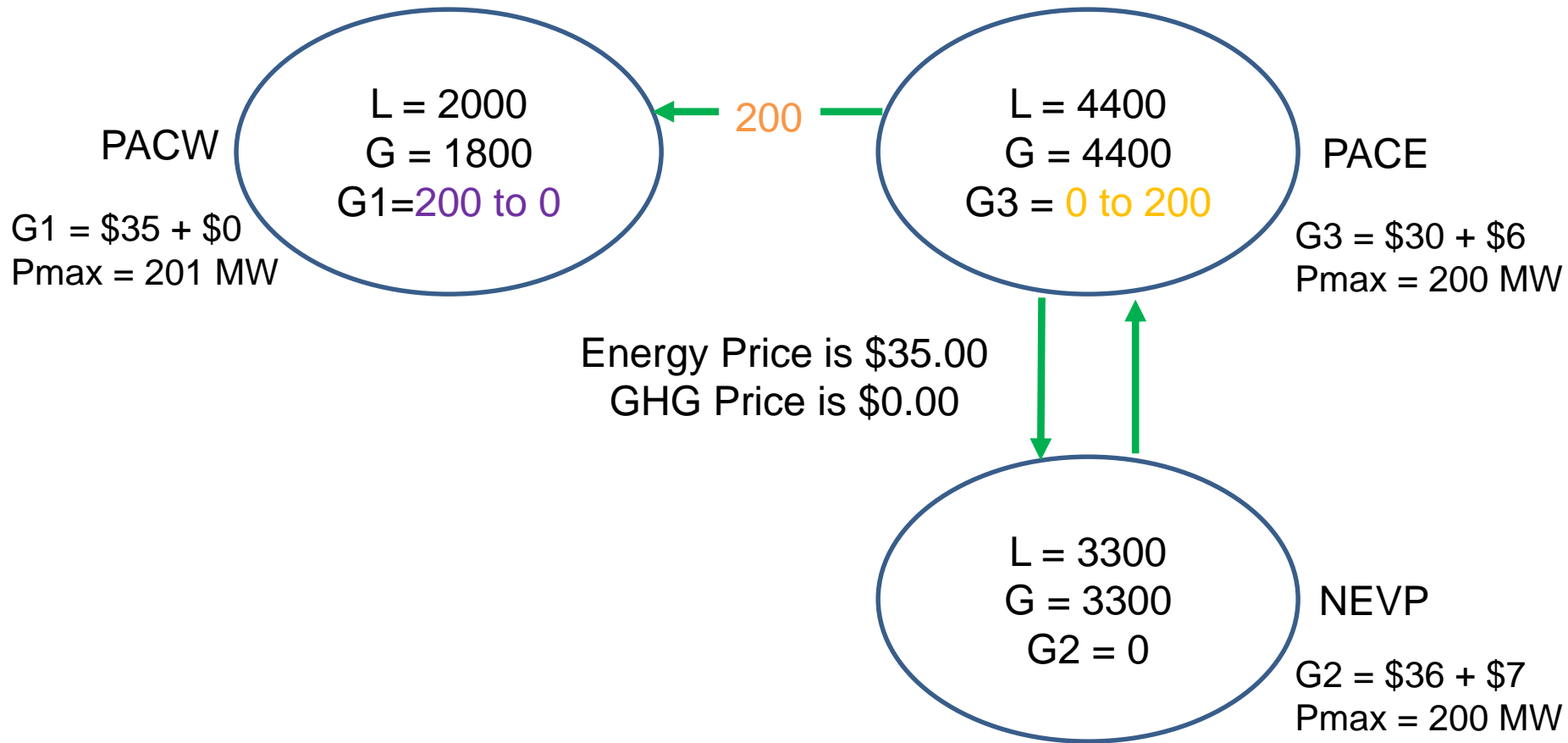
G1-G3 PMin 0 MW
GHG MW for all is 200 MW
Transfer limit into ISO is 201 MW

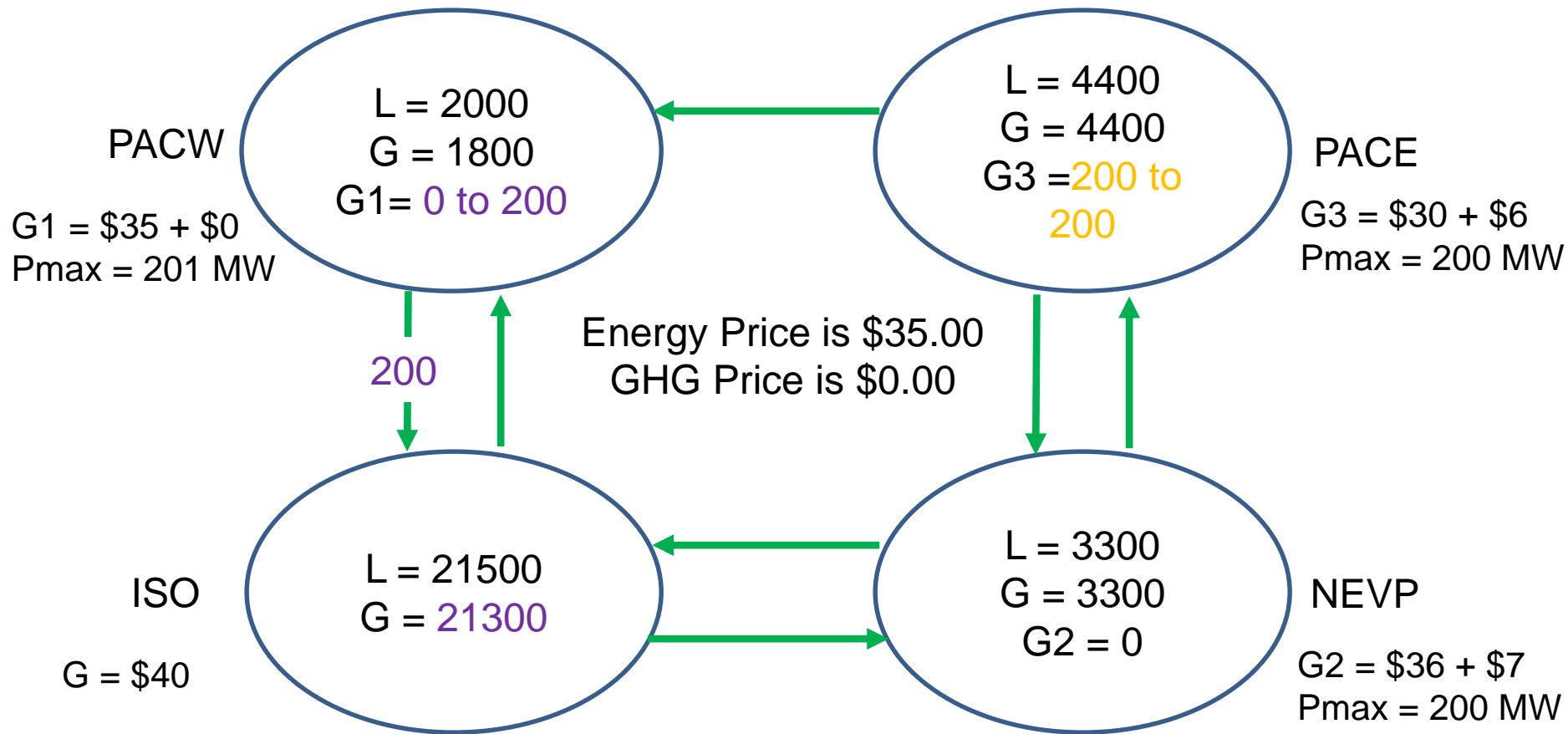California ISO

Let's solve the market for the EIM footprint

PACW

L = 2000
G = 1800
G1=200 to 200

G1 = $35 + $0
Pmax = 201 MW

← 200 →

PACE

L = 4400
G = 4400
G3 = 0 to 200

G3 = $30 + $6
Pmax = 200 MW

↓ 200 ↑

Energy Price is $35.00
GHG Price is $0.00

ISO

L = 21500
G = 21300

G = $40

NEVP

L = 3300
G = 3300
G2 = 0

G2 = $36 + $7
Pmax = 200 MW

Is this an example of "secondary dispatch" because the base schedule of G1 is attributed to ISO?

California ISO

Now let's assume the EIM entities optimized their base schedules before including the ISO

PACW

L = 2000
G = 1800
G1=200 to 0

G1 = $35 + $0
Pmax = 201 MW

200

PACE

L = 4400
G = 4400
G3 = 0 to 200

G3 = $30 + $6
Pmax = 200 MW

Energy Price is $35.00
GHG Price is $0.00

NEVP

L = 3300
G = 3300
G2 = 0

G2 = $36 + $7
Pmax = 200 MW

G3 increases its output and G1 reduces its output because G3 is lower cost than G1.
LMP outside ISO is $35

Now let's optimize from the prior slide's starting point and include the ISO

PACW

L = 2000
G = 1800
G1= 0 to 200

G1 = $35 + $0
Pmax = 201 MW

PACE

L = 4400
G = 4400
G3 =200 to 200

G3 = $30 + $6
Pmax = 200 MW

200

Energy Price is $35.00
GHG Price is $0.00

ISO

L = 21500
G = 21300

G = $40

NEVP

L = 3300
G = 3300
G2 = 0

G2 = $36 + $7
Pmax = 200 MW

This is the same dispatch level, but there is no secondary dispatch.

LMP inside ISO is $35. LMP outside ISO is $35.

California ISO

EIM transfers to the ISO do not always create a secondary dispatch

- Cannot assume base schedules are optimal before start of the EIM
  - Re-dispatch for economics or congestion independent of meeting a transfer to the ISO

- If a resource would have been dispatched down economically outside of the ISO, it shouldn't be a "secondary dispatch" when then used to meet ISO load

- The current EIM base schedule is not a good reference point to determine atmospheric effect

California ISO

Two pass solution that maintains resource specific cost and attribution (1 of 2)

- GHG award only if the resource is incrementally dispatched above new "GHG allocation base" to support EIM transfer into ISO

- Submitted base schedules are used for imbalance settlement solely and are not optimized outside of CA

- Requires a two-step process
  - Step 1: optimize schedules outside of CA without transfers to CA in order to determine "GHG allocation base" and not inappropriately impact LMPs and dispatch opportunity outside of CA
  - Step 2: optimize transfers to CA and compare with step one to determine incremental dispatch responsible

Two pass solution that maintains resource specific cost and attribution (2 of 2)

- Real-time dispatch is used to operate the grid
  - Must solve market optimization within 5-minutes
  - Solving the market twice to add GHG accounting functionality
  - Current computational power would require simplifying (less accurate) first pass to ensure RTD successfully completes

- GHG accounting accuracy is significantly improved, small "leakage" can still occur when starting with optimized (or not perfect) external schedules
  - Simplifying assumptions needed to reduce solve time of first pass
  - Can't let the perfect be the enemy of the good

ISO posted illustrative model of two pass market optimizaiton

- See excel workbook at:

  http://www.caiso.com/Documents/IllustrativeModel-CurrentGreenhouseGasDesignComparedtoProposedTwoPassOption.xlsx

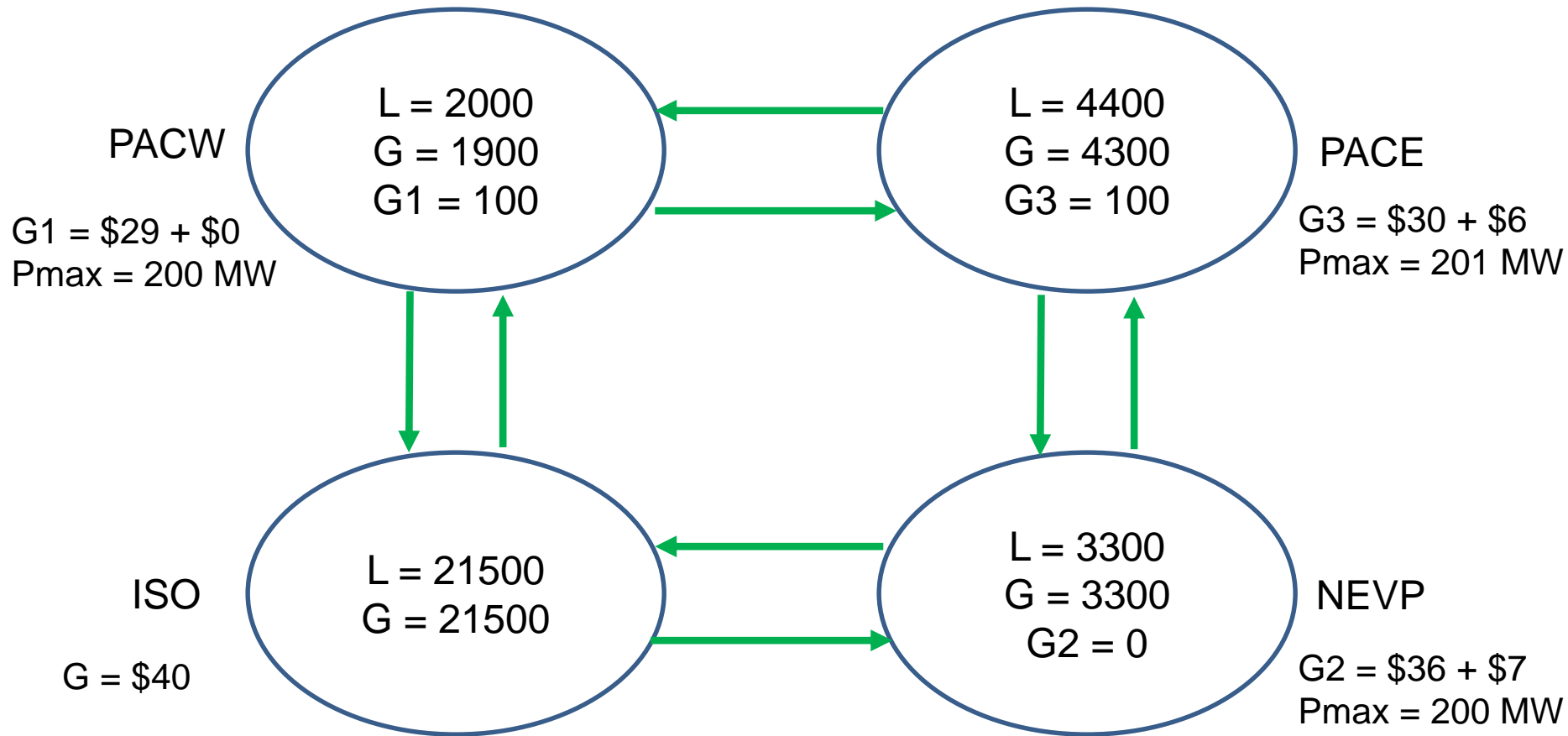- Solver add-in must be active

California ISO

How should ISO treat an external resource under contract to an load inside the ISO?

- Assume a California load serving entity has contracted with a wind resource in Oregon which bids $0.00 / MWh

- Using location only for the first pass, the Oregon unit could be used to back down a gas unit outside of California

- This would set the "GHG allocation base" of the wind resource to its forecast, thus this resource cannot be incrementally dispatched

- Therefore, the transfer can only be supported by incrementing a gas unit and incurring the GHG expense

Need to identify which supply is included in the first pass to determine the GHG allocation base for resources outside of California

- On an hourly basis, the SC for the resource can select the California supply flag

- All EIM participating resoruces located outside the ISO will bid a separate GHG component

- GHG allocation base equals the base schedule for California supply in EIM entity BAA
  - Addresses double counting base for GHG accounting

California ISO

Base assumptions for example to show need for California supply. G1 is "California" supply

PACW

L = 2000
G = 1900
G1 = 100

G1 = $29 + $0
Pmax = 200 MW

PACE

L = 4400
G = 4300
G3 = 100

G3 = $30 + $6
Pmax = 201 MW

ISO

L = 21500
G = 21500

G = $40

NEVP

L = 3300
G = 3300
G2 = 0

G2 = $36 + $7
Pmax = 200 MW

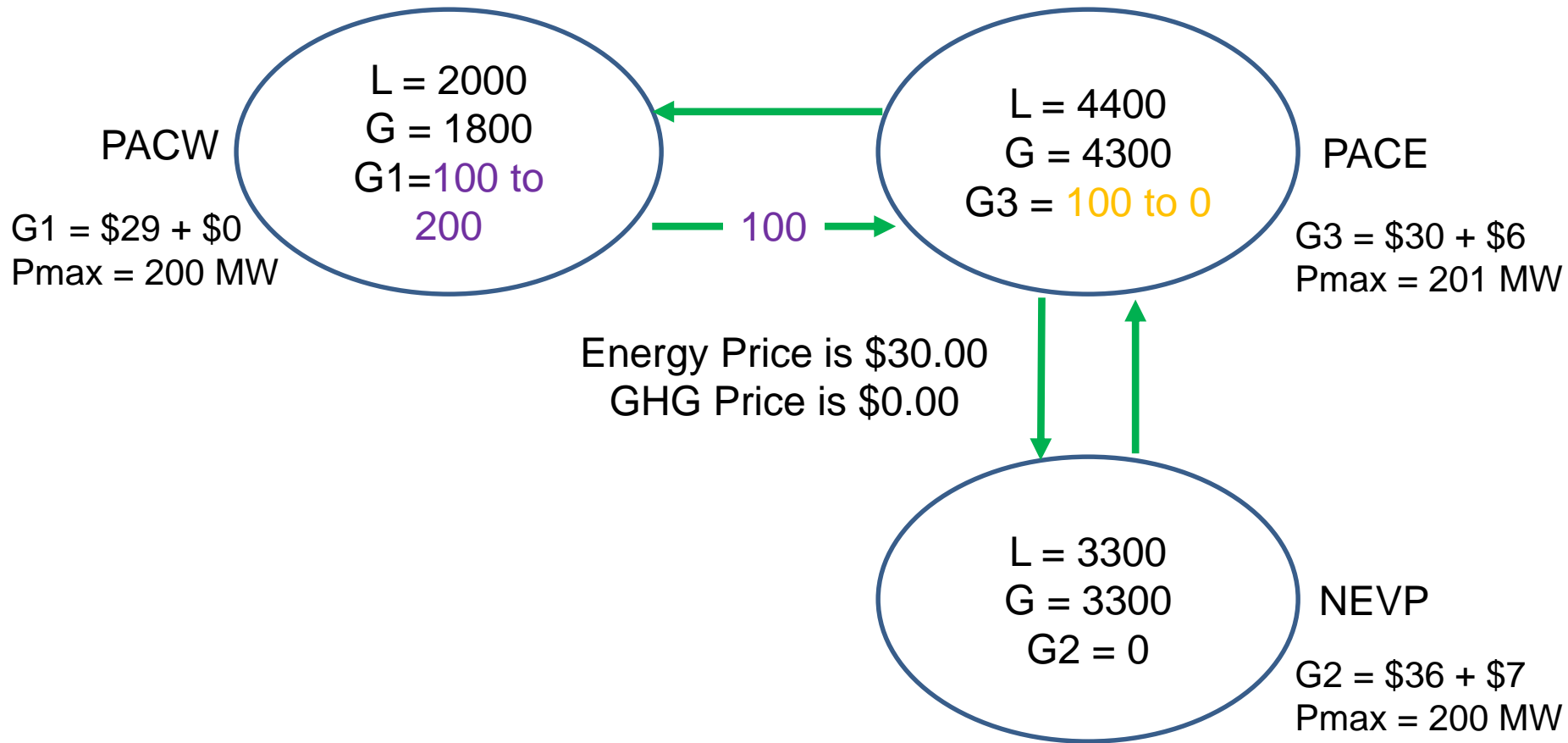Maximum reduction in ISO supply is **100 MW**

EIM Generator = Energy Bid + GHG Bid
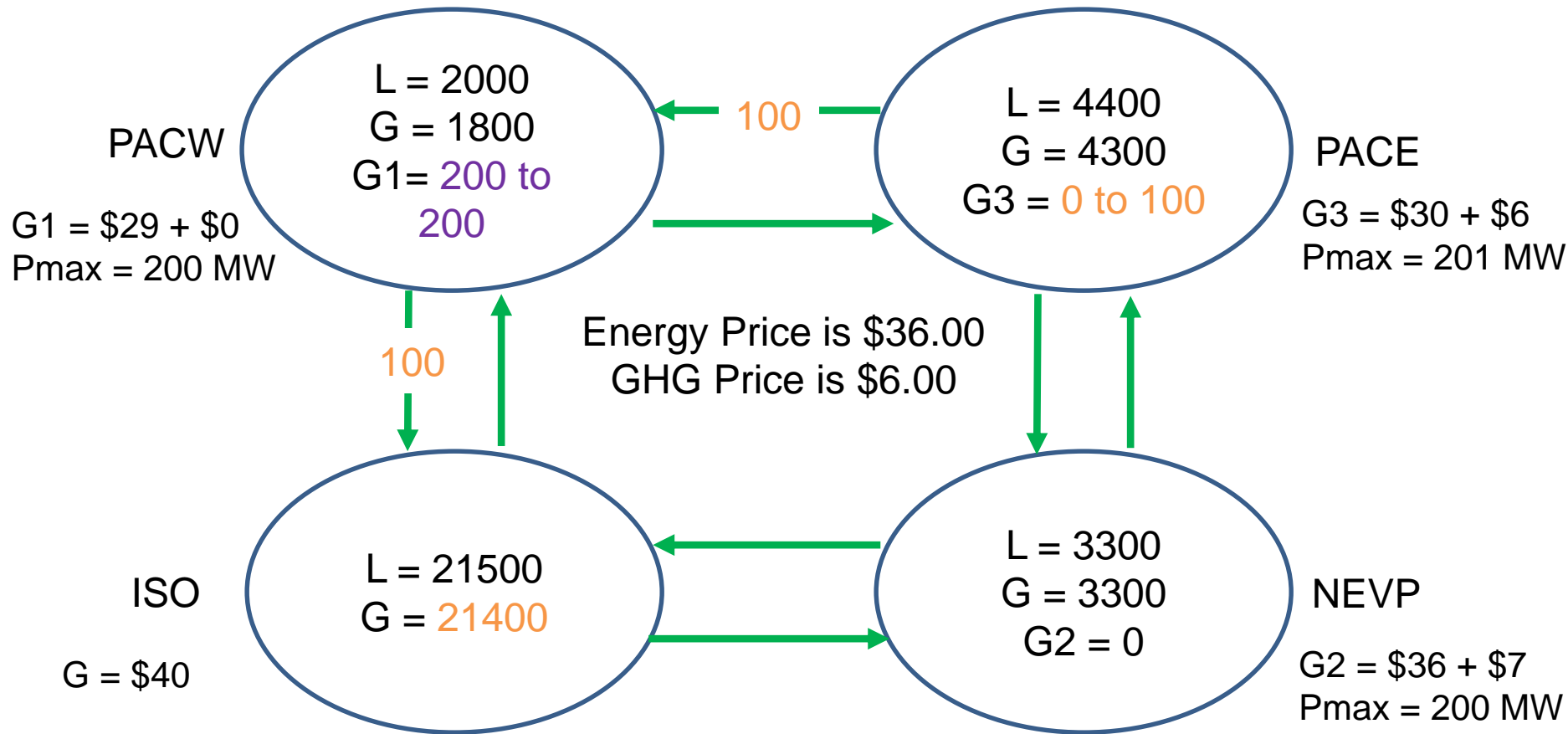
G1-G3 PMin 0 MW
GHG MW for all is 200 MW
Transfer limit into ISO is 201 MW

California ISO

Let's perform the first pass without considering G1 California supply

PACW

L = 2000
G = 1800
G1=100 to 200

G1 = $29 + $0
Pmax = 200 MW

100

L = 4400
G = 4300
G3 = 100 to 0

PACE

G3 = $30 + $6
Pmax = 201 MW

Energy Price is $30.00
GHG Price is $0.00

L = 3300
G = 3300
G2 = 0

NEVP

G2 = $36 + $7
Pmax = 200 MW

Economic to serve PACE load with G1

California ISO

Now let's perform the second pass optimize from the prior slide's starting point and include the ISO

PACW

L = 2000
G = 1800
G1= 200 to 200

G1 = $29 + $0
Pmax = 200 MW

← 100 →

PACE

L = 4400
G = 4300
G3 = 0 to 100

G3 = $30 + $6
Pmax = 201 MW

100

Energy Price is $36.00
GHG Price is $6.00

ISO

L = 21500
G = 21400

G = $40

NEVP

L = 3300
G = 3300
G2 = 0

G2 = $36 + $7
Pmax = 200 MW

Why should CA load incur a GHG cost when it contacted with G1?

LMP inside ISO is $36. LMP outside ISO is $30.

Now let's perform the second pass optimize with GHG allocation base for G1 equal to its base schedule

PACW

G1 = $29 + $0
Pmax = 200 MW

L = 2000
G = 1800
G1= 100 to 200

L = 4400
G = 4300
G3 = 0 to 100

PACE

G3 = $30 + $6
Pmax = 201 MW

100

Energy Price is $30.00
GHG Price is $0.00

ISO

G = $40

L = 21500
G = 21400

L = 3300
G = 3300
G2 = 0

NEVP

G2 = $36 + $7
Pmax = 200 MW
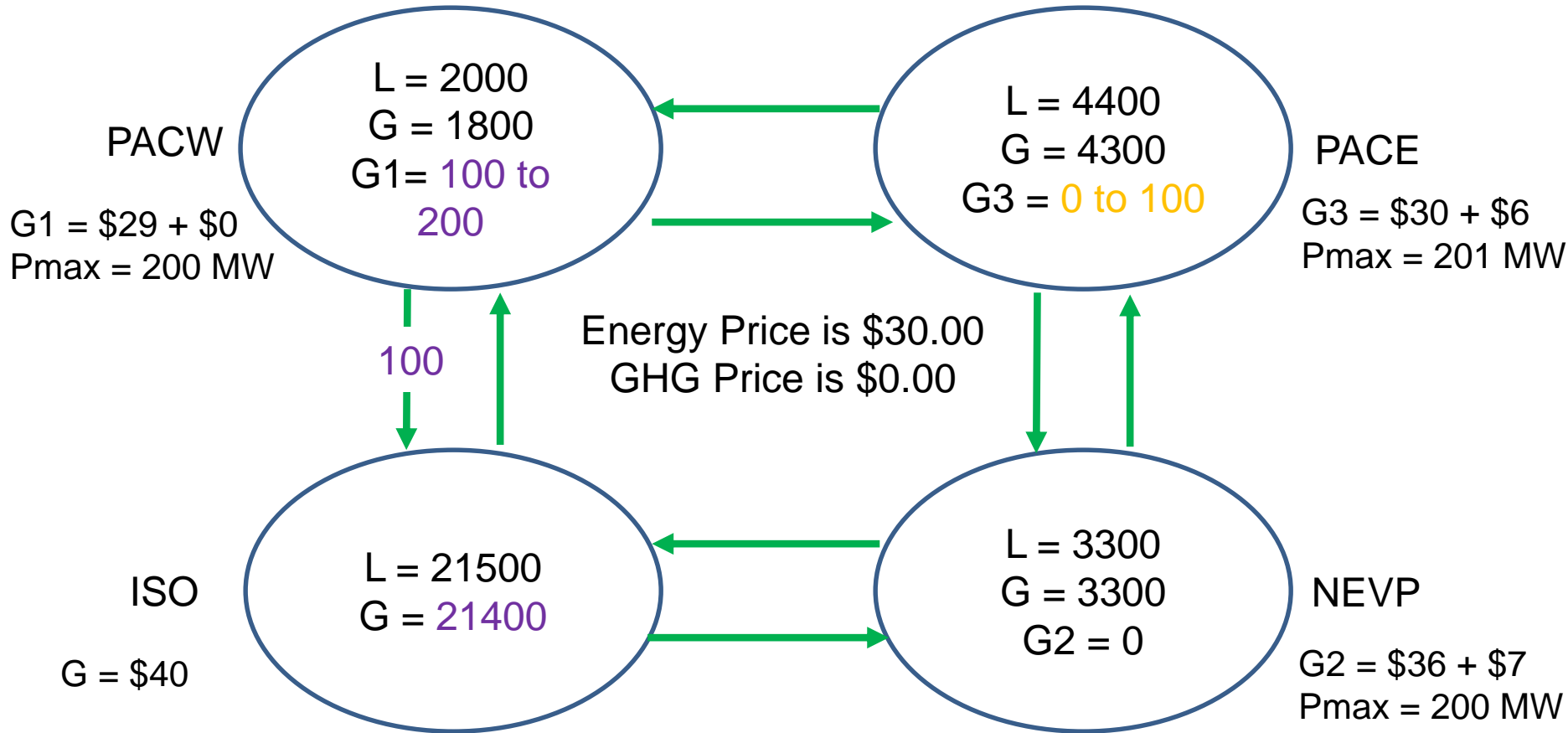
CA load benefits from contracting with non-emitting resource G1

LMP inside ISO is $30. LMP outside ISO is $30.

California ISO

ARB has proposed a bridge solution until the two pass solution can be implemented

- ARB will retire allowances for the difference between the unspecified rate applied to EIM transfers in the ISO and the attributed emission determined through the market optimization

- ISO will provide a report end of this year that assesses the accuracy of the two pass solution to account for the atmospheric effect of serving ISO load

Proposed design to minimize the solve time of first pass

- Avoid a full unit commitment in the first pass
  - The unit commitment status of resources and the configuration state of multi-stage generators (MSGs) will be obtained from the MPM run.

- Ramp constraints will be relaxed
  - May be insufficient ramp capability to calculate a feasible solution in the first pass when the net transfer to California is constrained to be non-positive.
  - Can result in a GHG allocation base that is not ramp feasible between intervals.

Real-time market enhancements initiative from roadmap would improve renewable integration

- Integrate RTUC and RTD into single market optimization

- 5-minute unit commitment

- 5-minute ancillary service procurement

- 5-minute EIM resource sufficiency evaluation

- 5-minute market power mitigation (implemented in 2017)

Functionality for GHG attribution must work with renewable integration enhancements

Next Steps

Item	Date
Post Draft Final Proposal	May 24, 2017
Stakeholder Conference Call	May 31, 2017
Stakeholder Comments Due	June 14, 2017
EIM Governing Body Briefing	July 13, 2017
Board of Governors Briefing	July 26-27, 2017
Report on GHG Attribution Accuracy	Q4 2017
EIM Governing Body Decision	Q1 2018
Board of Governors Decision	Q1 2018
Implementation	Fall 2018

Please submit comments to InitiativeComments@caiso.com

California ISO

Appendix

Three top options have been considered to ensure EIM/regional GHG accounts for secondary dispatch effects

1. Calculate overall GHG impact based on comparison to counter-factual dispatch outside the market optimization

2. Modify ISO optimization, but maintain resource specific cost and attribution

3. Modify ISO optimization, residual emission rate for EIM transfers into ISO. No resource attribution of residual emissions.

At technical workshop, the ISO stated that …

- Option 1 may be inconsistent with ARB regulatory framework

- Option 2 was the best long term solution, but could not be implemented immediately

- Option 3 could be implemented in 2017, but was not an optimal long term solution

California ISO

Principles the ISO used to determine which option should be pursued (1 of 3)

- Track emissions impacting the atmosphere as a result of generation outside California dispatched by the ISO market to serve California load

- Reflect those emissions in ARB's GHG regulations

- Allow suppliers selling power to serve California load to recover their costs to comply with ARB's greenhouse gas regulations from the ISO market

- Mitigate the impact of the ISO market's GHG tracking mechanism on the ISO market's prices for electricity to serve load outside of California

Principles the ISO used to determine which option should be pursued (2 of 3)

- Ensure solution is scalable to a regional ISO balancing authority area and integrated market, including the day-ahead market

- Resources located outside of California must be able to opt out of supporting EIM or regional transfers to serve California load that would be subject to ARB GHG regulations

- Output from resources located outside of California serving load outside of California cannot be part of a transfer into California and are thus not subject to ARB GHG regulations

California ISO

Principles the ISO used to determine which option should be pursued (3 of 3)

- If possible, regional and EIM transfers serving California load should be subject to similar regulatory requirements as other electricity supply serving California load. This allows resource specific emission rates to be considered and that scheduling coordinators remain the point of regulation as first delivers.

- If possible, consider how solution may align with GHG regulatory programs in other states/provinces, the extension of the Western Climate Initiative to states or provinces participating in the EIM or regional energy market, or state implementation plans under the Clean Power Plan.

Additional considerations under regional integration, i.e. becoming a multi-state balancing authority

- Extend two pass solution to day-ahead market

- Imports/exports of multi-state balancing authority area

- GHG regime and convergence bidding

- Supporting multiple GHG regimes

Extending the two pass solution to day-ahead does not have the same performance concerns as RTD

- Since there is no base schedule, the two pass solution is needed to address allocation to non-emitting resources first that are used to serve non-California load

- Will use the same first pass assumptions as RTD to ensure consistency between day-ahead are real-time markets

California ISO

Under multi-state balancing authority area, treatment of imports/exports will change

- For California cap-and-trade program, currently gross imports have a compliance obligation

- Under new paradigm, only imports that are attributed to support a flow into the California will have a compliance obligation

- Thus, the total compliance obligation will be the greater of California load or dispatch of generators geographically located in California

California ISO

Convergence bids are treated the same as internal generators serving load within a given state

- Virtual supply does not submit a separate GHG bid adder. Cannot support a transfer to another state

- Virtual demand is not exposed to costs of other state's GHG program when region is exporting

- Since trading hubs and LAPs are eligible bidding nodes, these aggregation are restricted to a single GHG regime

California ISO

If a GHG regime places a compliance obligation on imported electricity …

- Generators within that GHG regime embed GHG compliance cost in energy bid

- Another separate GHG bid adder for resources outside that GHG regime

- In the first pass, do not allow incremental transfers into the GHG regime from the non-GHG regime area or another GHG regime

- In second pass, allow incremental transfers into the GHG regime from all other areas

Assume three GHG regimes with both the blue and yellow regimes have obligation on external supply

GHG Regime
GHG Regime
Non-GHG Regime
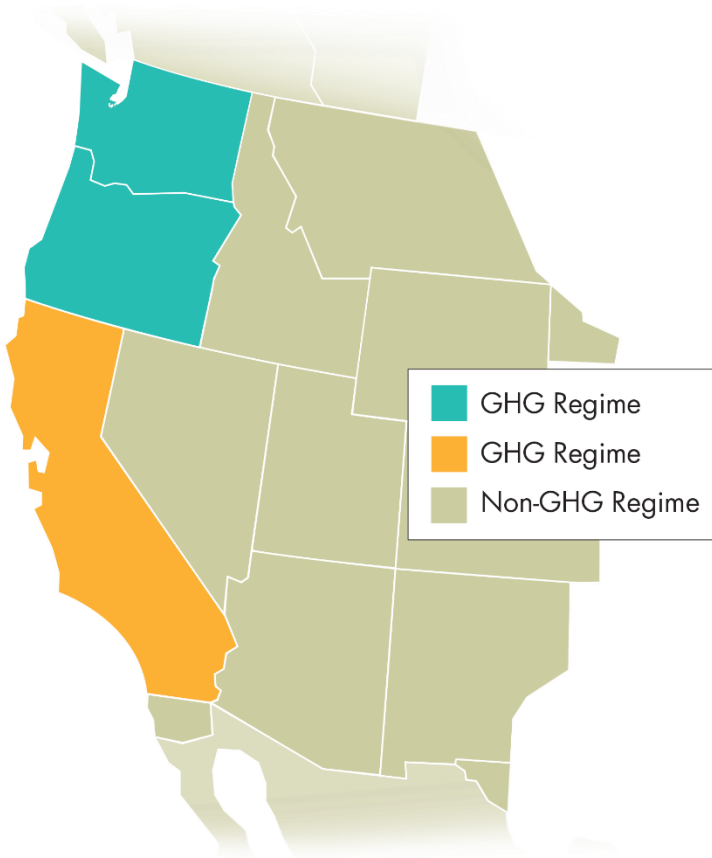
Blue generators
- Include blue GHG cost in energy bid
- Submit separate GHG bid to serve yellow regime load

Yellow generators
- Include yellow GHG cost in energy bid
- Submit separate GHG bid to serve blue regime load

Grey generators
- No GHG cost in energy bid
- Submit separate GHG bid to serve blue regime load
- Submit separate GHG bid to serve yellow regime load

Imports/exports to multi-state balancing authority area
- No GHG cost in energy bid
- Submit separate GHG bid to serve blue regime load
- Submit separate GHG bid to serve yellow regime load

First pass to establish GHG allocation base used in second pass

GHG Regime
GHG Regime
Non-GHG Regime
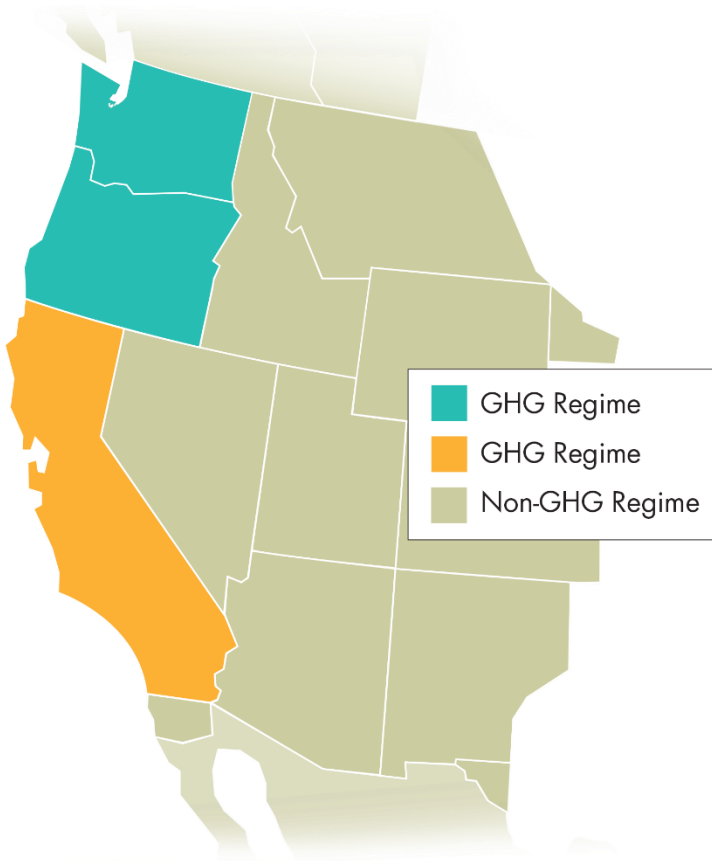
Blue regime
- No incremental transfers from yellow or grey regime contracted supply

Yellow regime
- No incremental transfers from yellow or grey regime contracted supply

California ISO