AFRICAN INFRASTRUCTURE INVESTMENT MANAGERS

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IRP UPDATE, 2016

CONSULTATION 13TH DEC 2016

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OUTLINE

- **A good start**
  - It has been provided, enabling the next step in our adaptive planning
  - Notwithstanding potentially overestimated costs and constraints on renewables, it makes the initial case for strong long term growth in the IPP sector in which we invest
- **Planning for adaptation**
- **Clarification and corrections**
  - **Capacity credit and penetration levels**
  - **Cost of integration**
- **Consultation materials**
- **Synopsis of Recommendations**

Outline

PLANNING FOR ADAPTATION

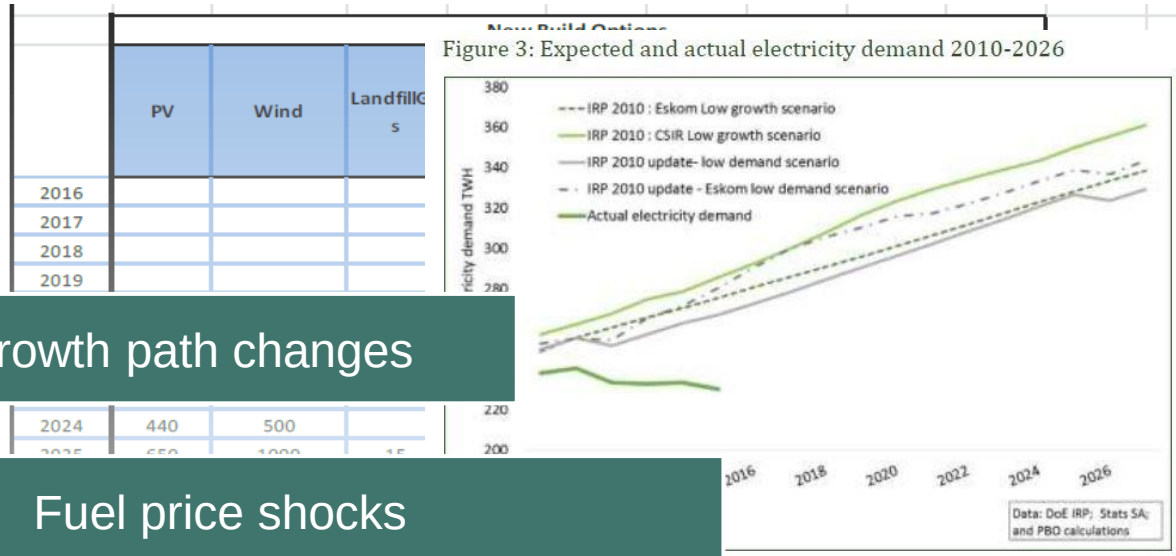
We think we're looking at this

	New Build Options											
	PV	Wind	LandfillGas	DR	Nuclear	OCGT	CCGT	Coal PF w FGD	Inga	CO2 Emissions	Peak Demand (MW)	Firm Reserve Margins (%)
2016												
2017												
2018												
2019												
2020										253	44916	24
2021	160									264	46130	28
2022	160									268	47336	23
2023	370	200								272	48547	20
2024	440	500		1000		396				279	49656	18
2025	650	1000	15	1000		2376	732			278	51015	19
2026	580	1000	5	1000		264	1464			278	52307	19
2027	580	1000	230	1000		264	2196			276	53561	19
2028	580	1000		500		396	1464	1500		277	54567	20
2029	580	1100		1000			1464	1500		273	56009	18
2030	580	1200		1000		1716		2250	1000	274	57274	20
2031	580	1200		1000		1584		750		274	58630	20
2032	580	1000		500			732	1500	1000	278	59878	22
2033	580	1200					1464	750	500	276	61388	23
2034	580	1600		1000		1452				278	62799	22
2035	580	1600		500			1464	1500		278	64169	23
2036	580	1600		1000				1500		278	65419	21
2037	580	1400		500	1359		732	2250		277	66993	22
2038	580	1600				1848	1464	750		273	68375	22
2039	650	1500			1359		2928			267	69584	22
2040	650	1600		1000		1056	732			261	70777	20
2041	650	1600		1000	4077	792		750		236	72343	21
2042	650	1600		500			2196			233	73800	21
2043	650	1600		500						232	75245	21
2044	650	1800		500	1359					228	76565	21
2045	770	1600			2718		2196			230	78263	23
2046	790	1600		500	1359	924				225	79716	20
2047	720	1800		1000	1359		732			219	81177	19
2048	720	1600		500	2718	264				211	82509	20
2049	660	1500		500	1359					206	84213	20
2050	720	1400		500	2718					196	85804	20
Total (MW	17600	37400	250	500	20385	13332	21960	15000	2500			

Considering **2050** numbers like 30-106 GW of wind and 13-50 GW of solar PV

PLANNING FOR ADAPTATION

However, it's more like this



Demand growth path changes

Fuel price shocks

Defection

e.g. California

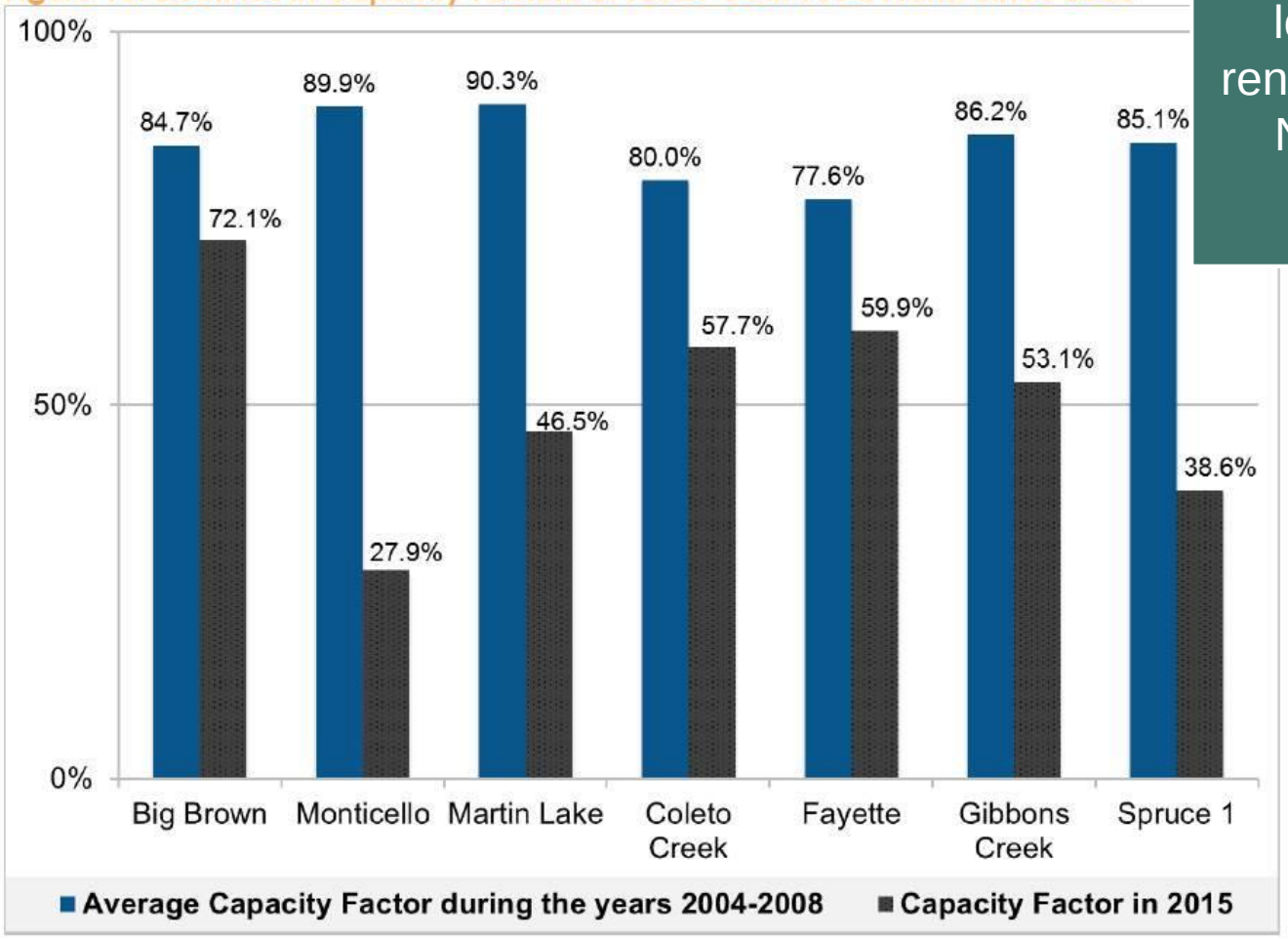
Disruption

e.g. Tesla, electric vehicles and storage

"I'm not really a fan of disruption; I'm just a fan of things being better." - Elon Musk

PLANNING FOR ADAPTATION

Figure 10: Declines in Capacity Factors at Texas Coal-Fired Plants Since 2008[24]

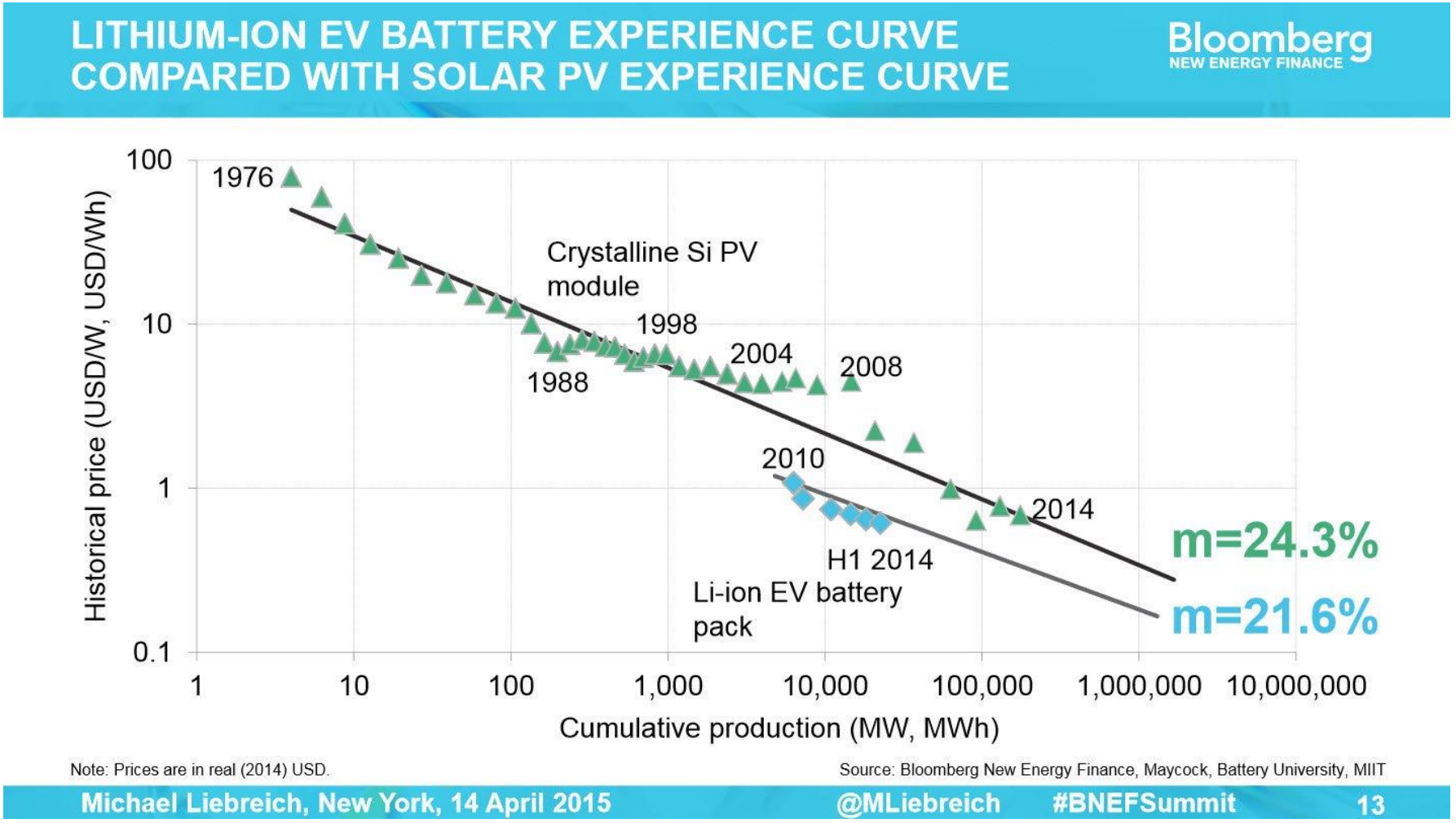


Example

Due to disruption of the market, long-serving coal plants in Texas are no longer competitive, crowded out by renewables and facing rising coal costs. Now running at low load factor and facing closure.

Learning rates on storage

- Energy Storage Costs Fell 70% in 2yrs, Faster Decline than Solar Power:



PLANNING FOR ADAPTATION

Uncertainty is not a scenario – it is a given.

PLANNING FOR ADAPTATION

Hence base case and all other scenarios should be adaptive.

Adaptation requires

- The planning process to be responsive: strictly regular IRP updates
- The model to assign value to shorter lead time and smaller unit size

Long lead time bulk units are a liability.

Example

The world has changed since Medupi and Kusile were procured.

We now have excess capacity and are stuck still building inflexible capacity at higher cost per kWh than current new-build alternatives

Suggestion

Assign higher value in the model to

- Shorter lead time
- Smaller unit size

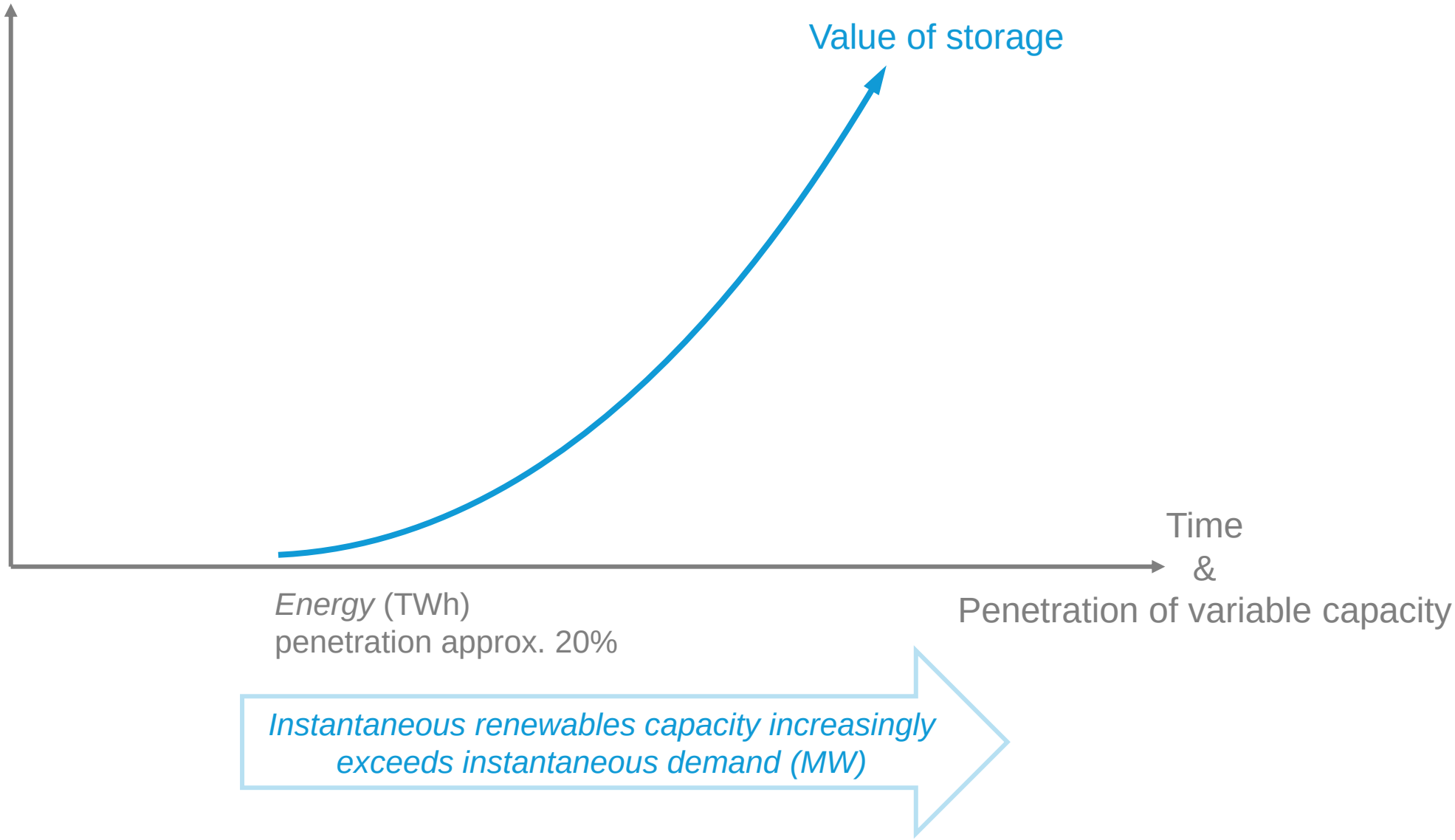
ADAPTIVE SCENARIO

With

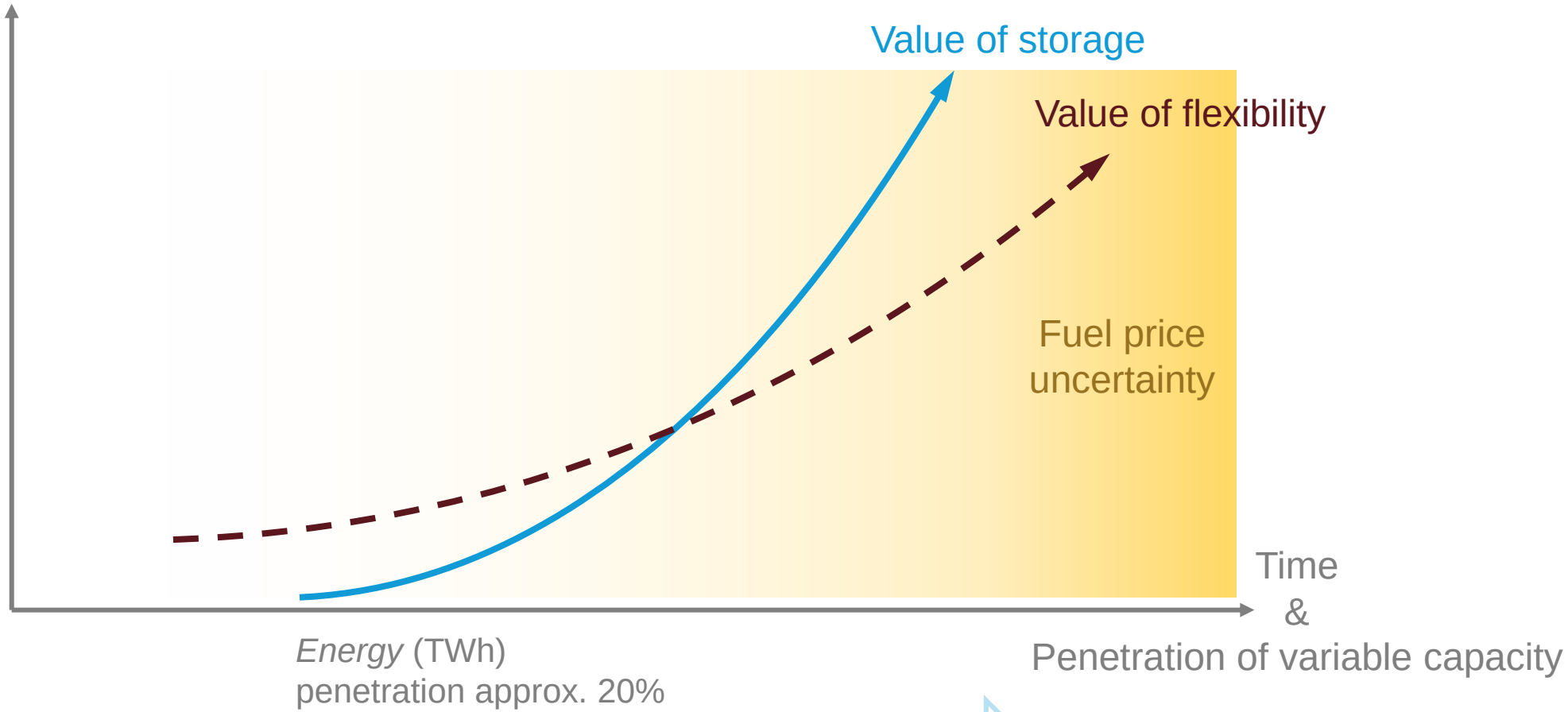
- higher value assigned to short lead time, smaller units,
- strategic transmission investment and
- uncapped renewables in the medium-to-long term

we move to a lower risk scenario

EXAMPLE DISRUPTION: STORAGE LEARNING RATE

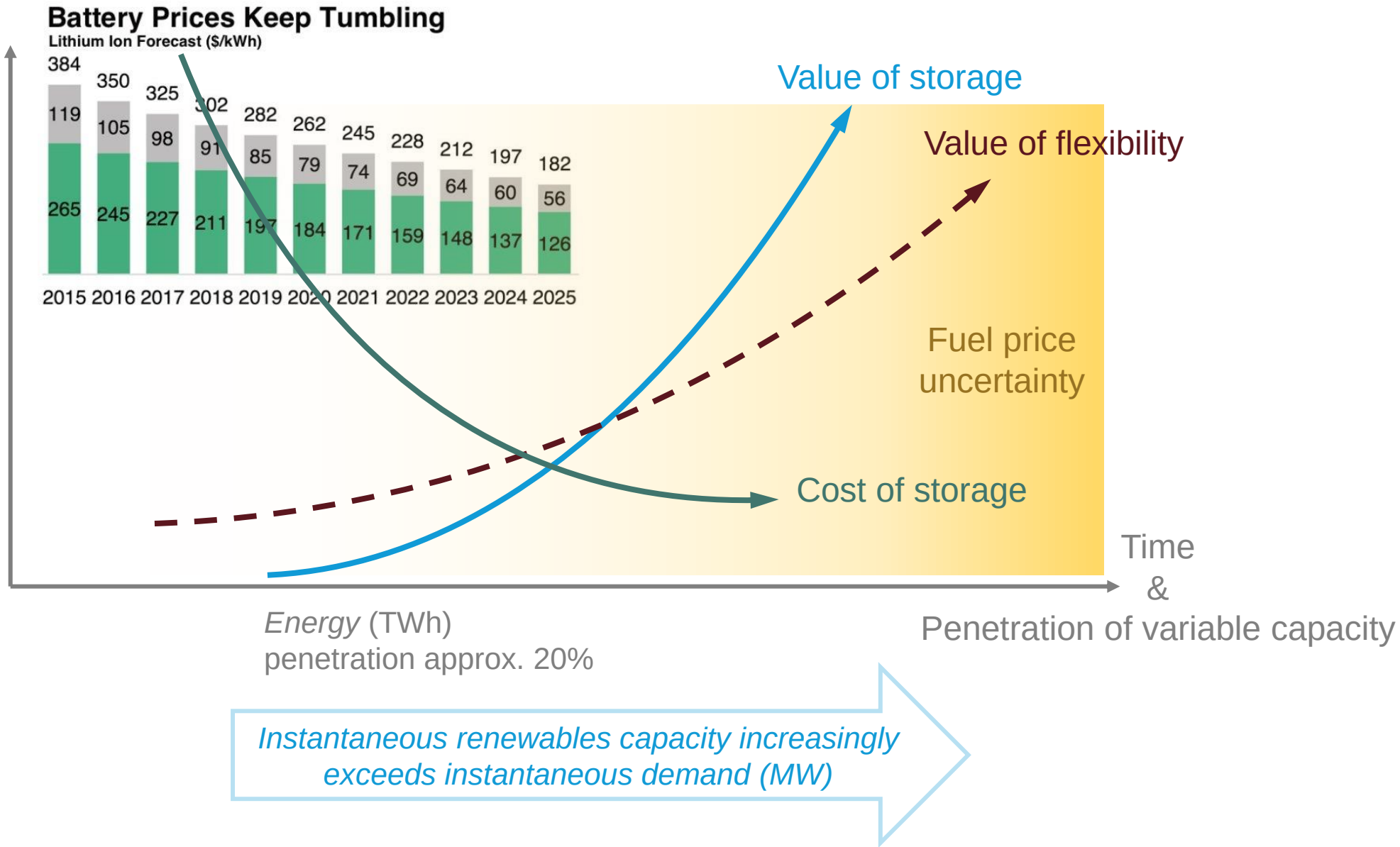


DISRUPTION: STORAGE LEARNING RATE



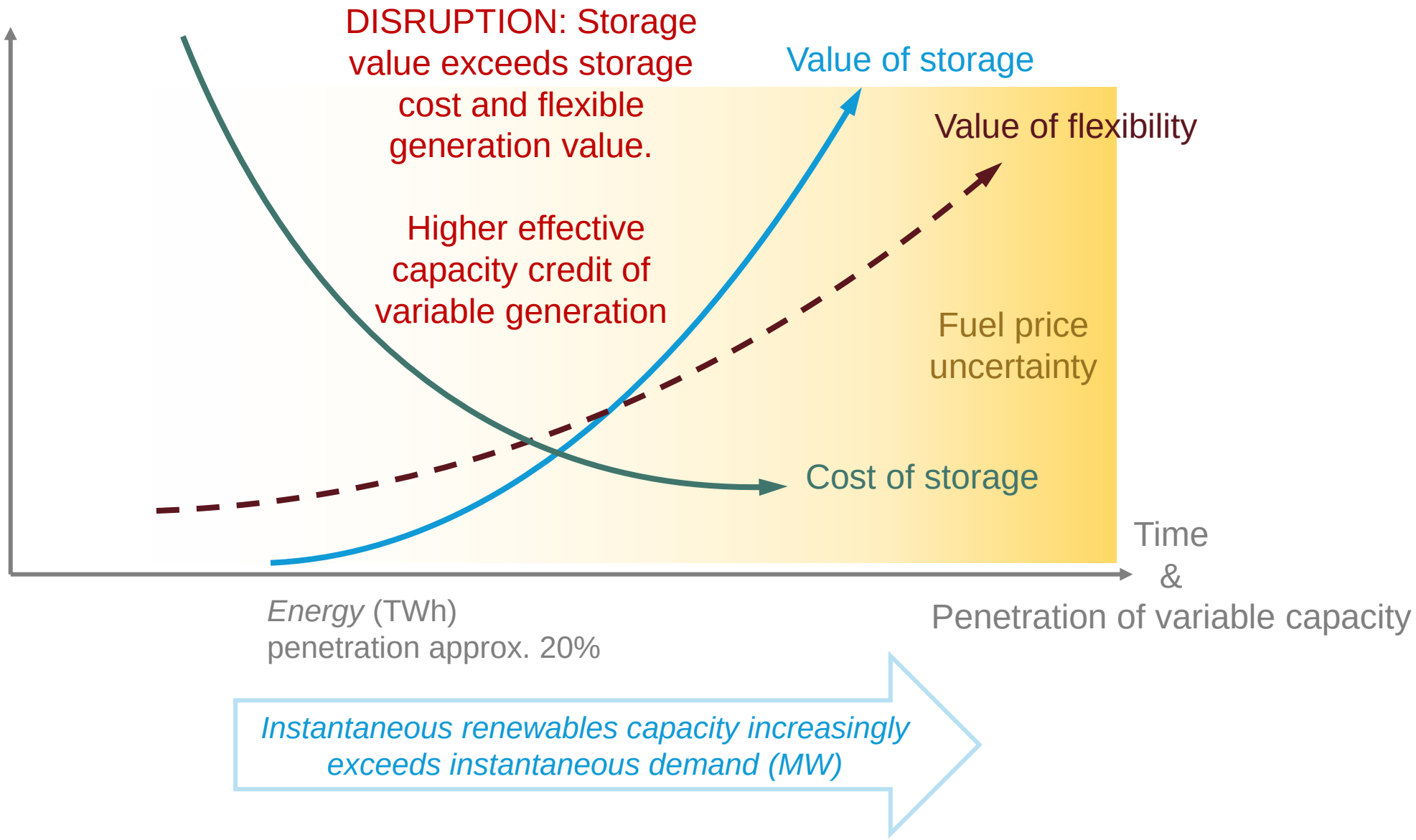
Instantaneous renewables capacity increasingly exceeds instantaneous demand (MW)

DISRUPTION: STORAGE LEARNING RATE



"Battery Prices Keep Tumbling" BNEF, 2016

DISRUPTION: STORAGE LEARNING RATE



IMPACT OF STORAGE IN THE DISRUPTION HORIZON

Suggestion

1. Add learning rate to energy storage
2. Ensure model accounts for value of storage vs. cost of storage (i.e. at higher penetration, opportunity cost of curtailment vs. e.g. gas)

RENEWABLE ENERGY AND POWER PENETRATION

- Penetration levels:
  - Insufficient data in consultation pack to establish exact figures, however appears:
  - Base case:
    - Energy penetration reaches 10% around 2030, levels off around 25%.
    - Power penetration reaches 20% around 2030, no more than 50% by 2015.

BASE CASE	Energy	Power
2030	~10%	~20%
2050	~25%	<50%

Example

of over 10% energy penetration:

- Denmark (39.1%)
- Ireland (19%)
- Portugal (27%)

Spain at over 20% energy penetration is not a strongly interconnected network

Recommendation

Be more ambitious with penetration levels and relax imposed constraints on renewables build

COST OF INTEGRATION

Variable generation sources come under model interventions due to imposed constraints, ostensibly motivated by

1. Concern about grid infrastructure constraints
2. Concern about costs of managing variability

COST OF INTEGRATION: GRID INFRASTRUCTURE

- There is no motivating study of the Eskom network provided to quantify the annual cap considered
- Current tariffs under REIPPPP are inclusive of
  - Shallow connection upgrades
  - Increasingly at transmission level
  - Increasingly being assigned deep connection upgrade cost
- Current tariffs are still competitive, notwithstanding
- The REIPPPP tender process will self-regulate as these constraints materialise

Suggestion

Quantify costs of accelerated investment in strategic grid upgrades versus scenario cost of capped renewables, provide update by end Jan 2017

"COSTS OF VARIABLE GENERATION"

- The EPRI document displays
  - Some example figures, appearing to display some confirmation bias in selection of examples
  - References: Eskom and the Electric Reliability Council of Texas.
- It is unclear what assumptions may be used regarding integration costs in the model itself

Suggestion

1. Make model assumptions explicit.
2. Use diverse and reputable references such as IEA
3. Ensure that, where "integration costs" are considered, these do not double-count, e.g.
   a. Residual demand forecast uncertainty and associated load-following flexibility is accounted for in the choice of capacity mix. Do not count again as a cost associated with variable generation.
   b. Cost for generation when wind isn't blowing and sun isn't shining is defined in blended cost from model mix per kWh. Do not double-count in discussion as a "backup" requirement.

CONCLUSION

- The first pass at IRP2016 base case is encouraging in several respects
  - It has been provided, enabling the next step in our adaptive planning
  - Notwithstanding potentially overestimated costs and constraints on renewables, it makes the initial case for strong long term growth in the IPP sector in which we invest
- There are several areas of concern, with the following flagged here:
  - Consultation process inhibited by lack of information on key parameters
  - Cost of energy not reflective of current market
  - Consideration of “costs of integrating renewables” is unclear in the parameters and model intervention in scenarios is not motivated on defensible data.
  - Consideration of capacity credit in the calculation of “firm capacity” is unclear and less explicit than in IRP2010
  - Given uncertainties and disruptions in the energy market, the model does not assign higher value to options that give greatest **adaptability**

RECOMMENDATIONS

- **Make capacity mix plan adaptable:**
  - Assign higher value in the model to
    - Shorter lead time
    - Smaller unit size
- **Prepare for disruptions and trends**
  - Add learning rate to energy storage
  - Ensure model accounts for value of storage vs. cost of storage (i.e. at higher penetration, opportunity cost of curtailment vs. e.g. gas)
  - Make model respond to storage growth in consideration of combined capacity credit
- **Use defensible motivations on renewable energy considerations**
  - Clarify what assumptions are used on “firm capacity” with regards to each technology’s capacity credit
  - Use diverse and reputable references such as IEA.
  - Ensure that, where “integration costs” are considered, these do not double-count
- **Update consultation materials in time for written comment: no later than end January 2017**
  - Provide more in-depth supporting information, including TWh mix and total cumulative MW mix
  - Quantify costs of accelerated investment in strategic grid upgrades versus scenario cost of capped renewables
  - Make model assumptions explicit with regards cost of integration
- **Use current and correct data in assumptions**
  - Update screening curves from REIPPPP learnings on CAPEX
  - Align demand growth models between scenarios

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FURTHER CONSIDERATIONS

A Member of OLDMUTUAL ALTERNATIVE INVESTMENTS



CAPACITY CREDIT IN THE MIX

GENERAL CONCERNS

- It is unclear as to why the peak demand differs between these scenarios
  - Base case: **85 804 MW**
  - Base Case + Carbon Budget + No Annual Constraints on RE: **85 804 MW**
  - Base Case + Carbon Budget+ Annual Constraints on RE: **64 604 MW**
- Tariffs
  - Screening curves are not representative of current (REIPPPP Expedited) tariffs
- Consultation process is compromised
  - Lack of supporting documentation

Request

Align demand growth models between scenarios

Request

Update screening curves from REIPPPP

Request

Provide more in-depth supporting information no later than end January 2017

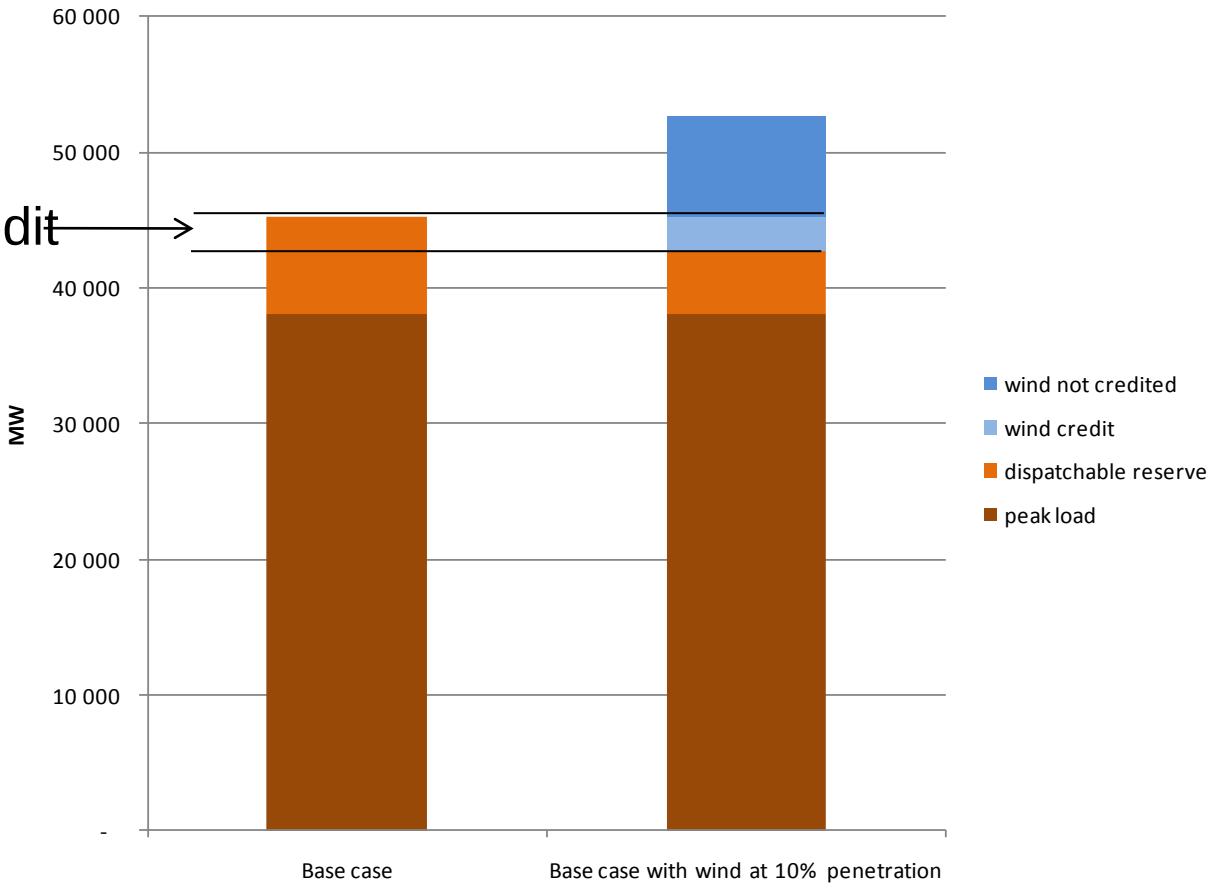
CAPACITY CREDIT

Example: Explanation of capacity credit in the context of reserve margin

- Reserve ideally 19% of peak demand

capacity credit

- "firm" reserve required is reduced by Capacity Credit



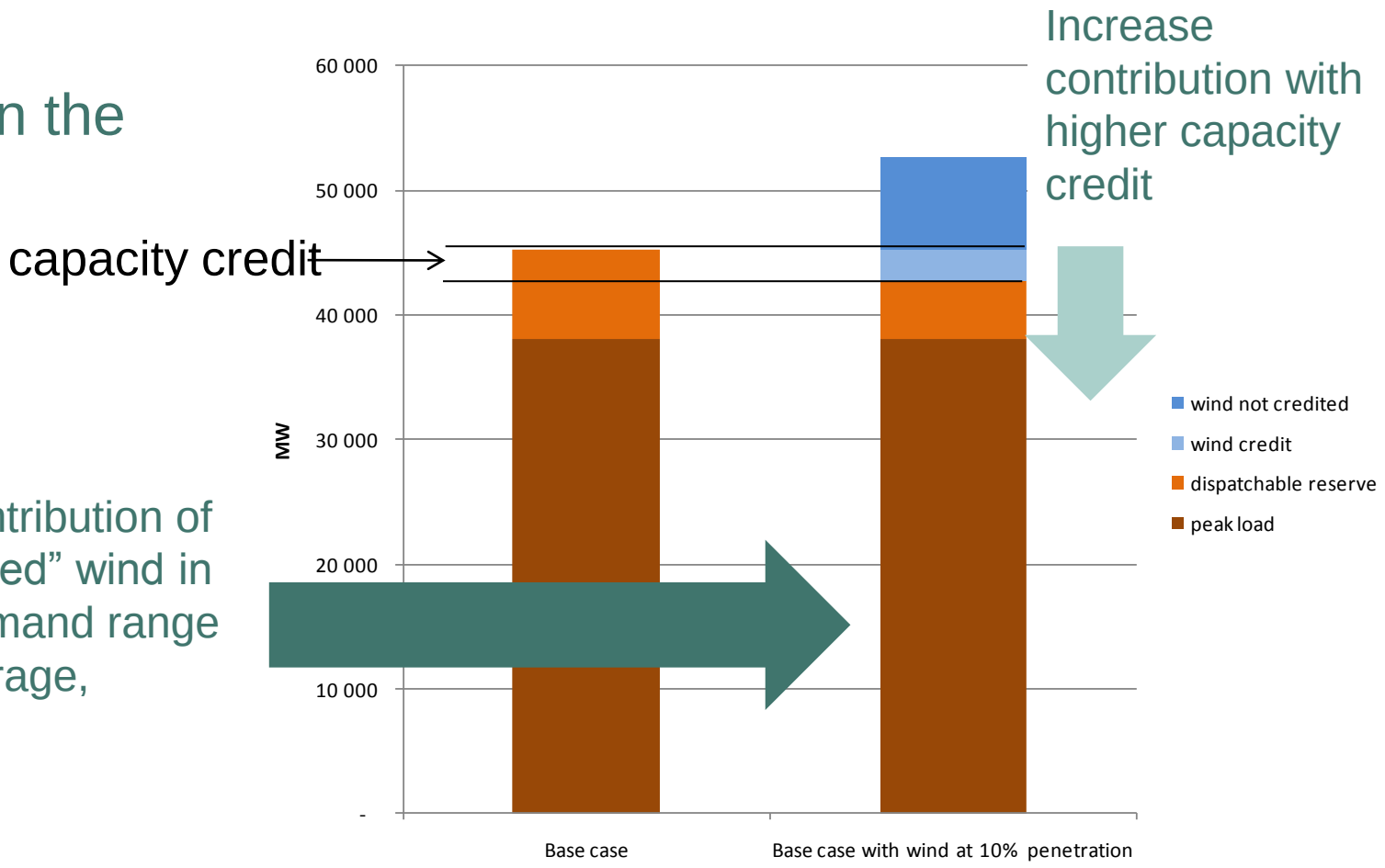
1. Boyle (2007), "Renewable Electricity and the Grid", Earthscan, London

CAPACITY CREDIT

Example: Explanation of capacity credit in the context of reserve margin

- Changes in the mix

Increase contribution of the “uncredited” wind in the peak demand range with e.g. storage, trading



1. Boyle (2007), “Renewable Electricity and the Grid”, Earthscan, London

CAPACITY CREDIT

- The provided documentation does not permit as much insight into how each technology's contribution to "firm capacity" is defined as was provided in 2010
- In 2010, the assumed capacity credit is described in some detail. In IRP2016 there are no specifics and, while the EPRI supporting document in 2010 provided some consideration, 2016's EPRI document refers to it in an offhand way with a single reference to some American examples. There is no reference to relationship to penetration or what figures are assumed.
- Total cumulative capacity, taking into account starting and retiring capacity is not provided in the supporting documentation so it's not possible to interrogate the mix properly.

Recommendation

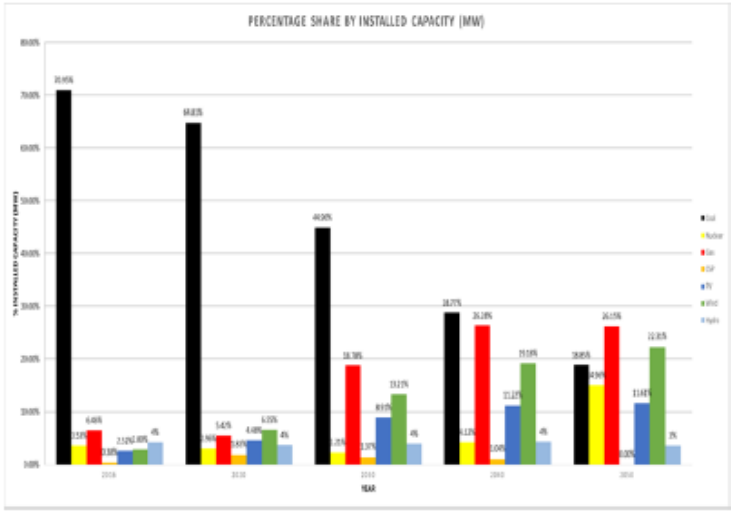
1. Clarify what assumptions are used on "firm capacity" with regards to each technology
2. Use diverse and reputable references such as IEA.
3. Make model respond to storage growth in consideration of combined capacity credit

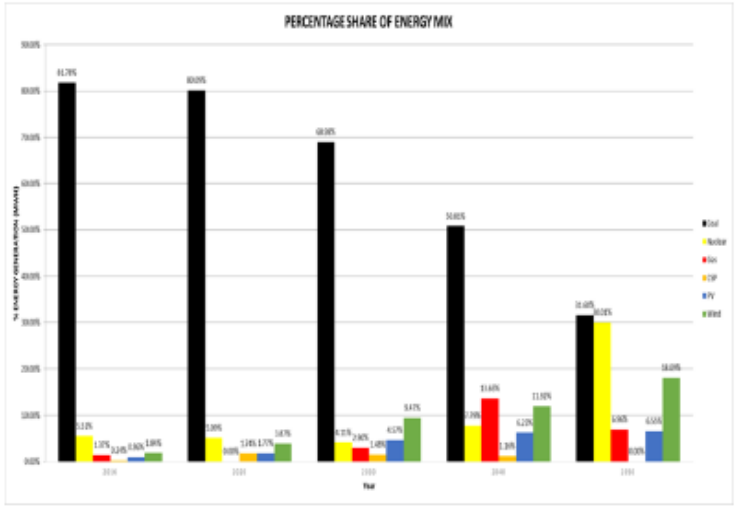
DATA FOR REVIEW

Request

Provide more in-depth supporting information no later than end January 2017, including TWh mix and *total cumulative* MW mix

IRP 2016 – illegible. TWh data not readily accessible in supporting documentation. Total cumulative capacity incorporating retirement unclear

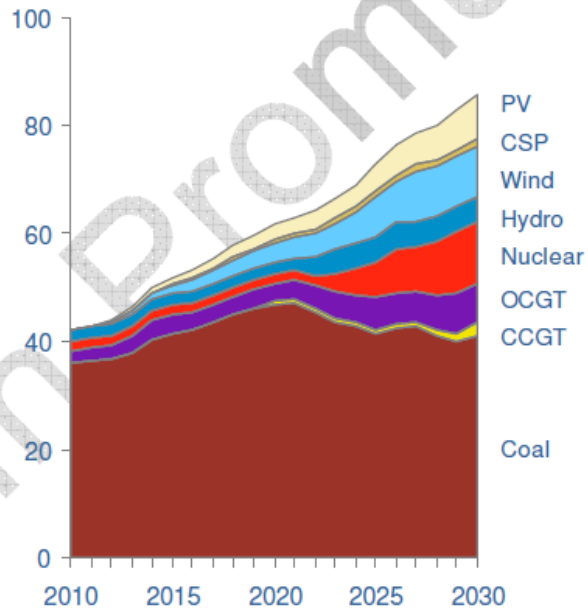




IRP 2010

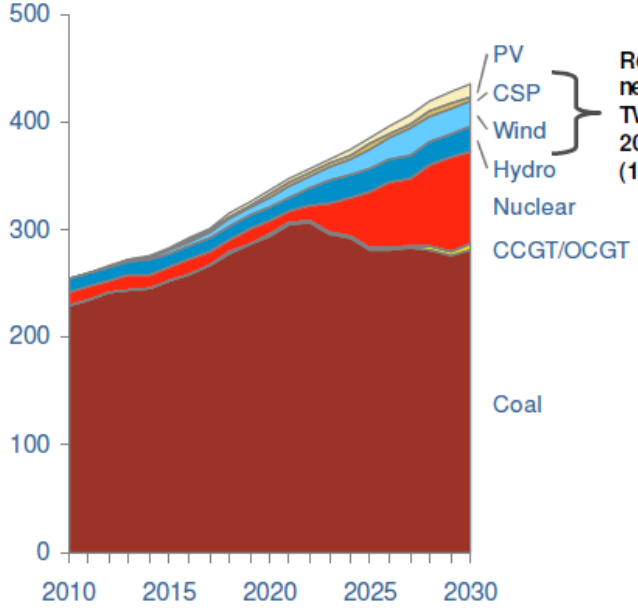
Sources of energy supply

Capacity installed EoY in GW[1]



Energy mix

Electric energy supplied in TWh p.a.



Re-newable TWh's in 2030 (14%)