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BLACK & VEATCH

# Renewable Energy Transmission Initiative Phase 1A Work Group Meeting 6

**Black & Veatch**

**Phase 1A Work Group**

**March 6, 2008**

# Agenda

- Actions taken last meeting
- Discussion of Coordinating Committee Meeting
- Carry-over items from 2/28/08 meeting
  - none
- CREZ identification, characterization and economic ranking
- Renewable technology-specific assumptions

# Actions Taken Last Meeting

- Base Case Definition
  - Generation included in Base Case
  - Transmission included in Base Case
- Review of resource assessment methodology
- Review of technology development methodology

# Generation Included in RETI Base Case

- Existing resources
- Projects under construction
- Projects with PPA, siting approval, and transmission agreements

*Same criteria used for California and non-California resources*

# Transmission Included in RETI Base Case

- Base Case:
  - Existing transmission
  - Transmission projects under construction
  - Transmission projects approved by **ALL** necessary regulatory agencies (FERC, CEC, CPUC, CAISO, etc.)
- Alternative scenario: above listed transmission and all CAISO-approved resources

*Same criteria used for California and non-California transmission projects*

# Discussion of March 5 Coordinating Comittee Meeting

- Anne Gillette

# Assumptions

- Financial assumptions for use in modeling ✓
- Renewable energy incentives ✓
- Renewable energy demand ✓
- Transmission ✓
- Economic assumptions to support resource valuation ✓
- Renewable technology-specific assumptions ← Today

# Methodological Issues

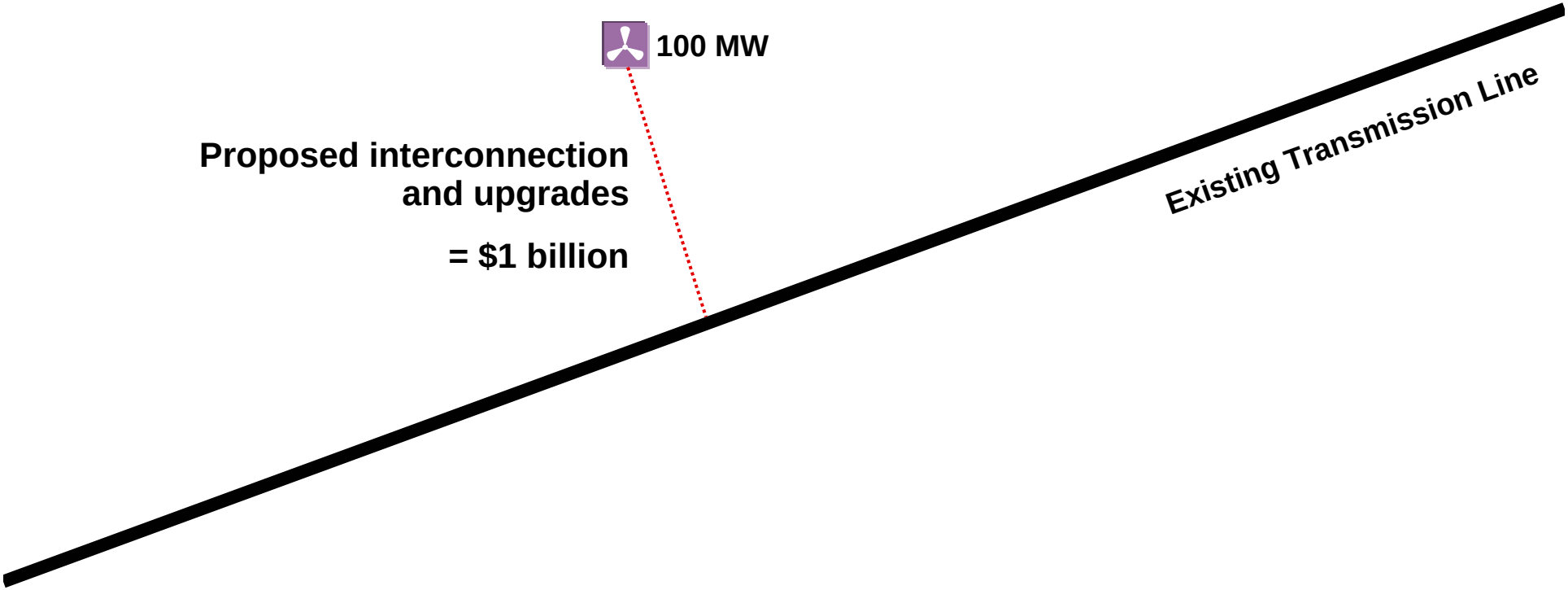
- Resource assessment
- Project identification, characterization and screening
- CREZ identification, characterization and economic ranking
- Treatment of existing and short-listed contracts and transmission queue
- Technology development
- Resource valuation
- Supply curve creation

Today

# What is a Competitive Renewable Energy Zone?

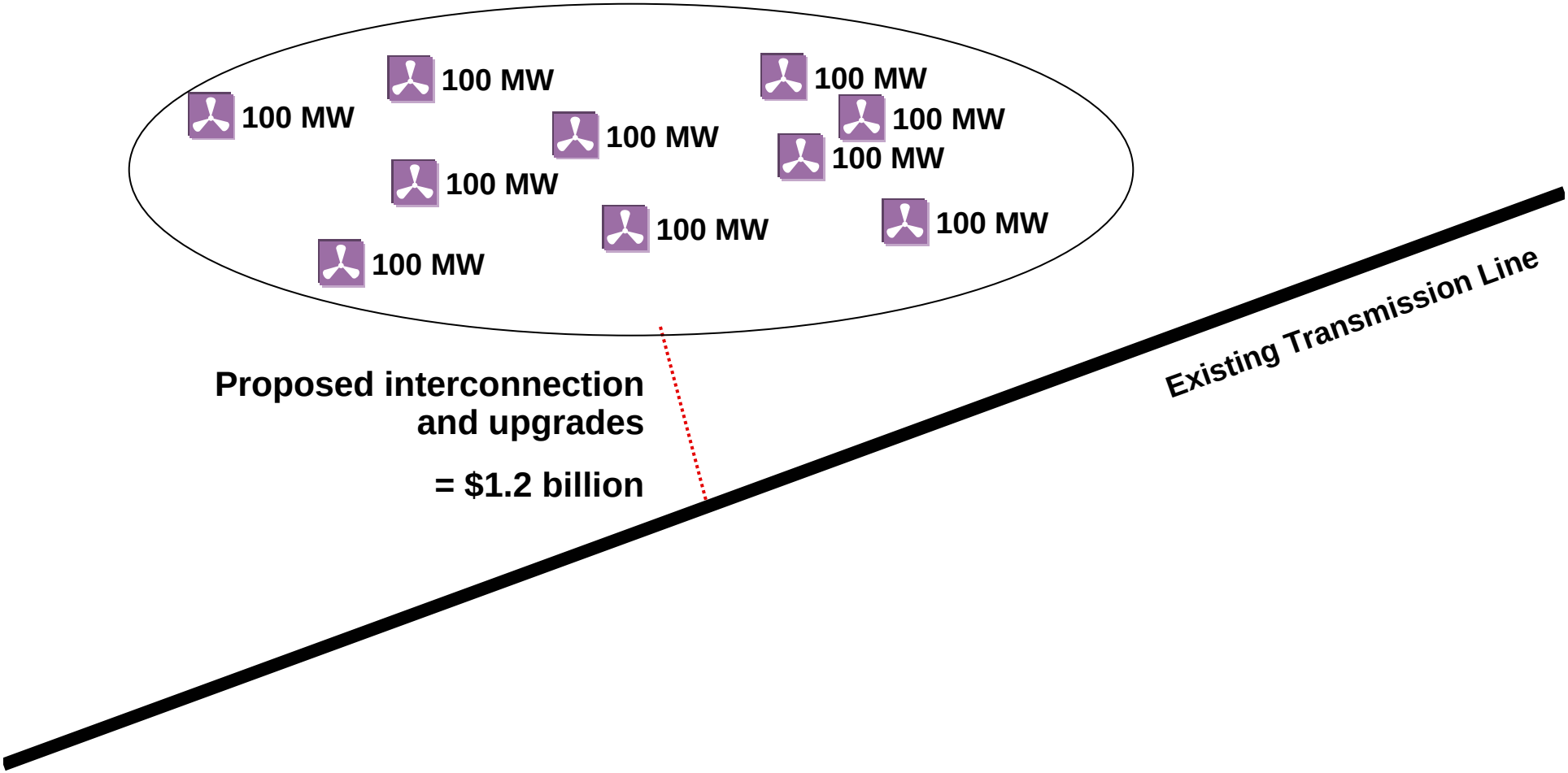
- A group of projects that when combined has improved economics (ie, *Economies-of-scale)*

# Simple CREZ Example




*CONCEPTUAL – FOR EXAMPLE ONLY*

# Simple CREZ Example

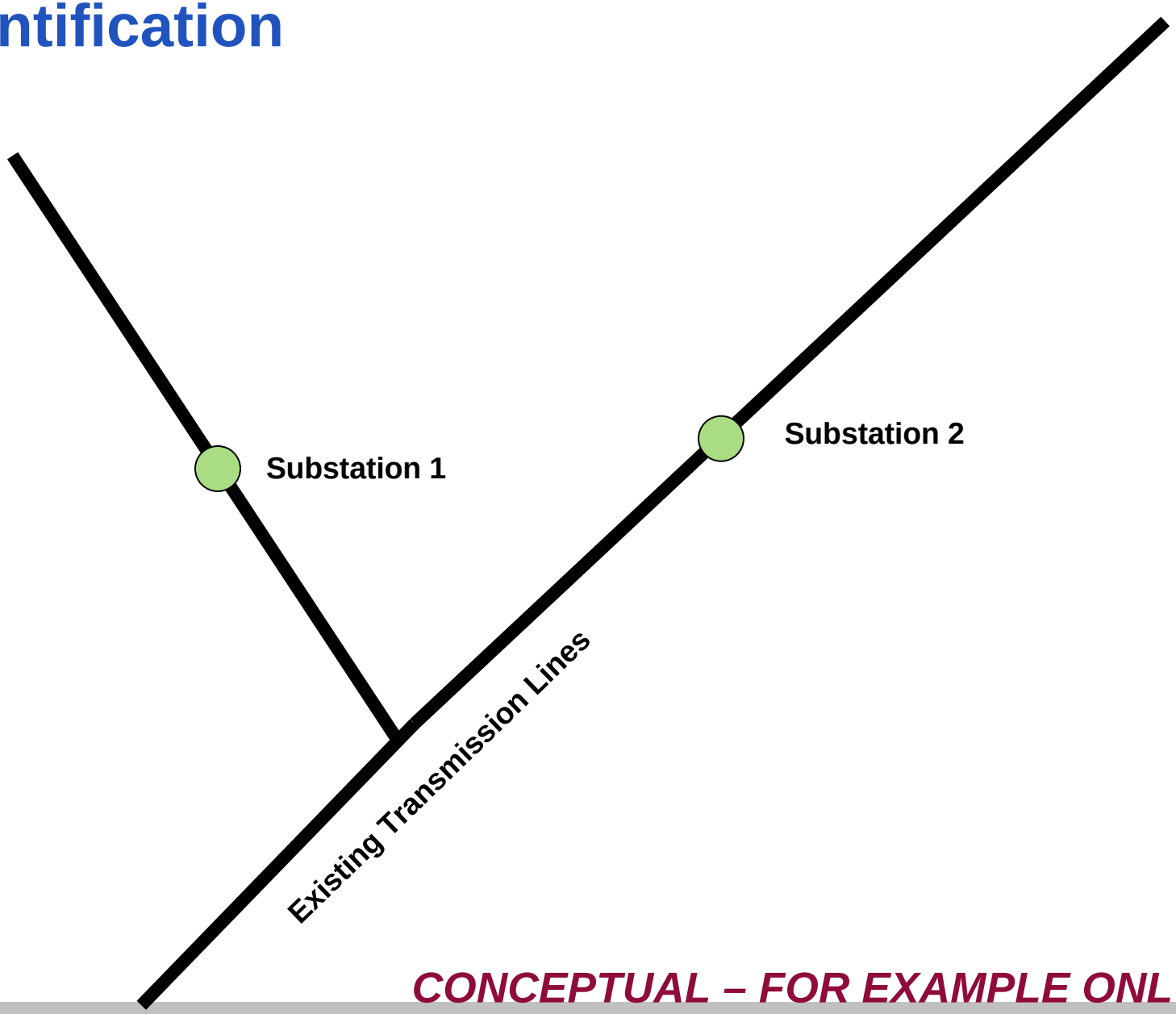



*CONCEPTUAL – FOR EXAMPLE ONLY*

# CREZ Identification, Characterization and Economic Ranking

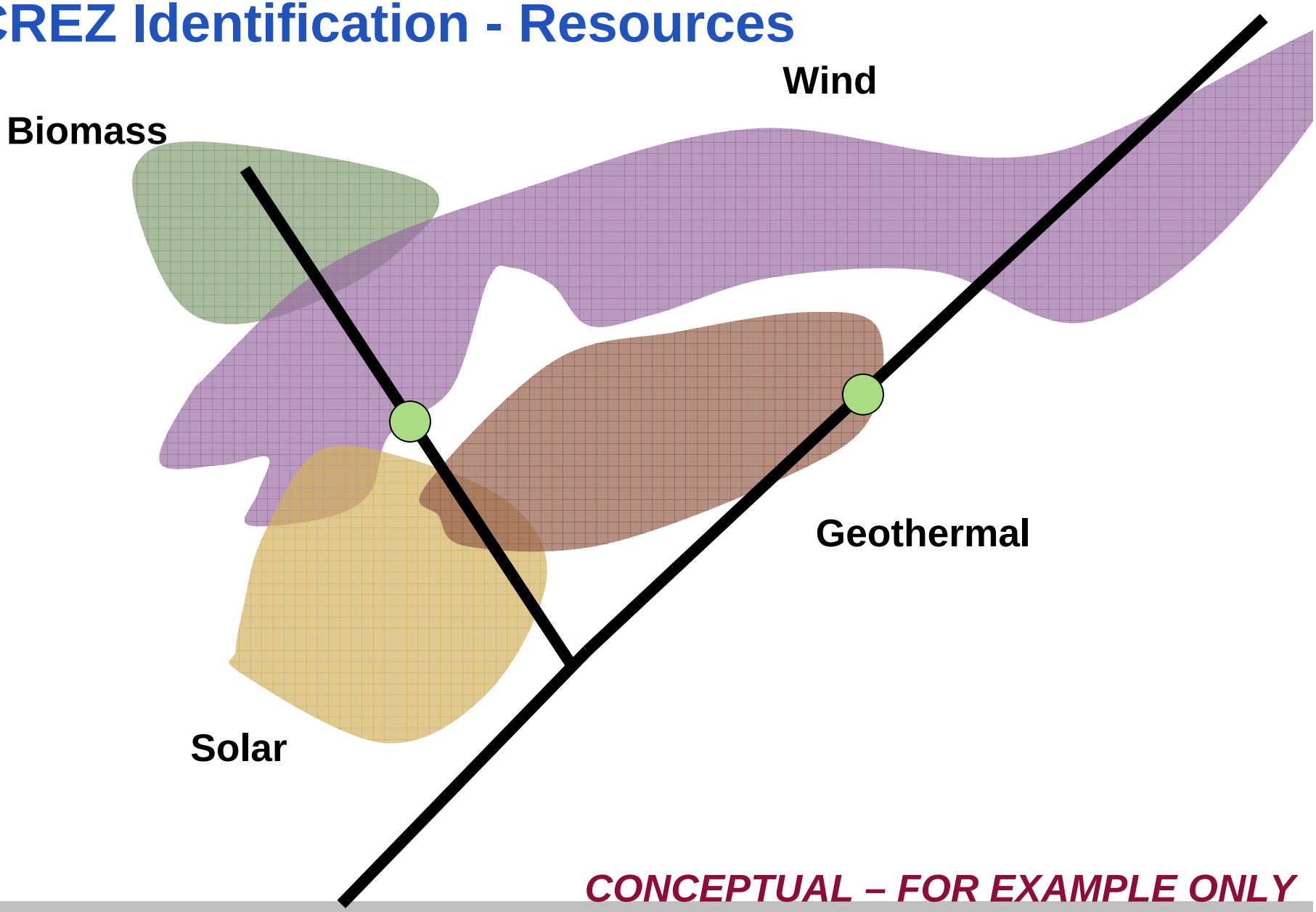
- CREZ will be characterized by the following:
  - Physical location
  - Electrical location
  - Development time frame (near-, mid-, and long-term)
- CREZ size will depend on transmission availability and resource capacity (MW)
- CREZ Economic Ranking – value of all resources in CREZ at given size

# CREZ Identification



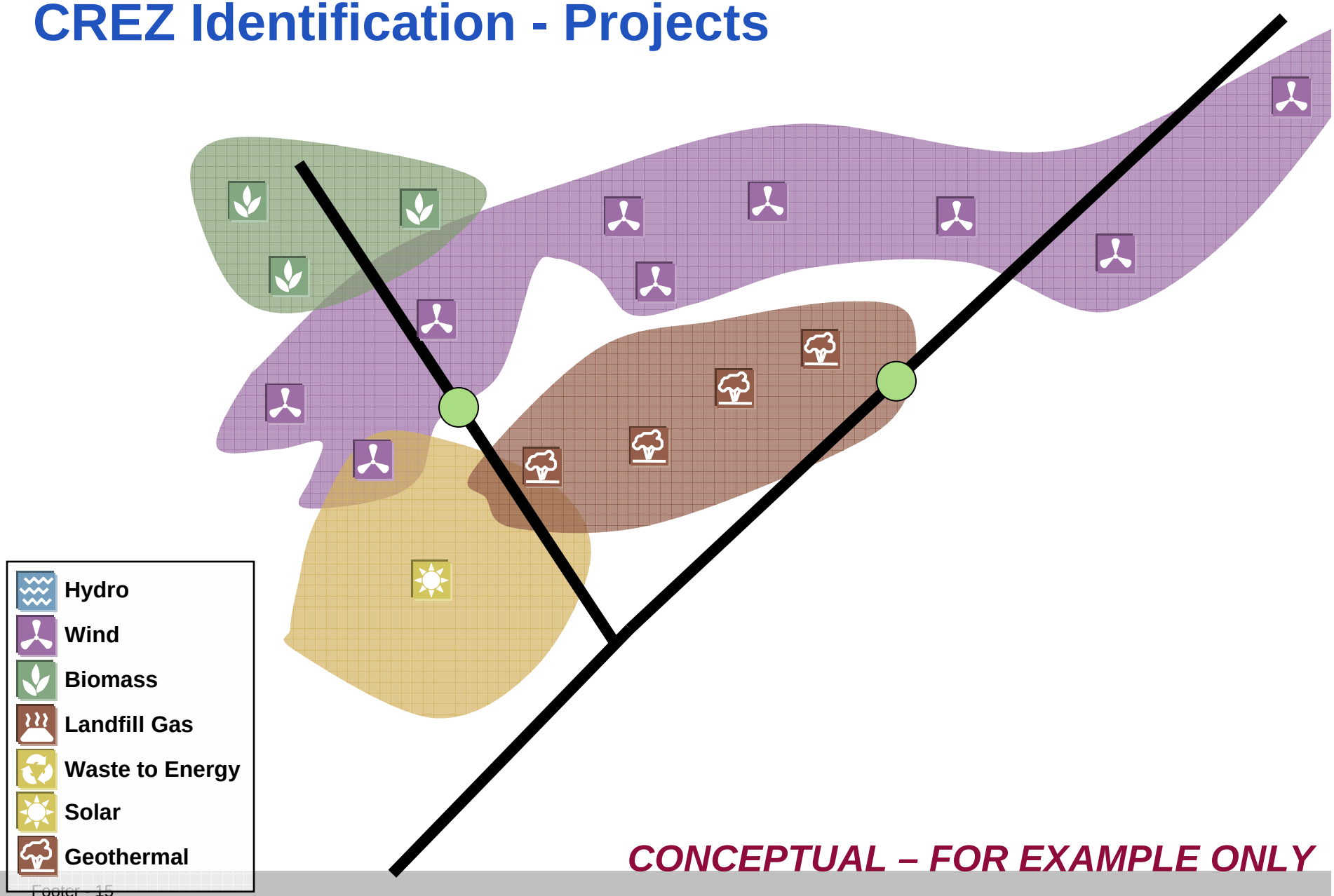

*CONCEPTUAL – FOR EXAMPLE ONLY*

# CREZ Identification - Resources



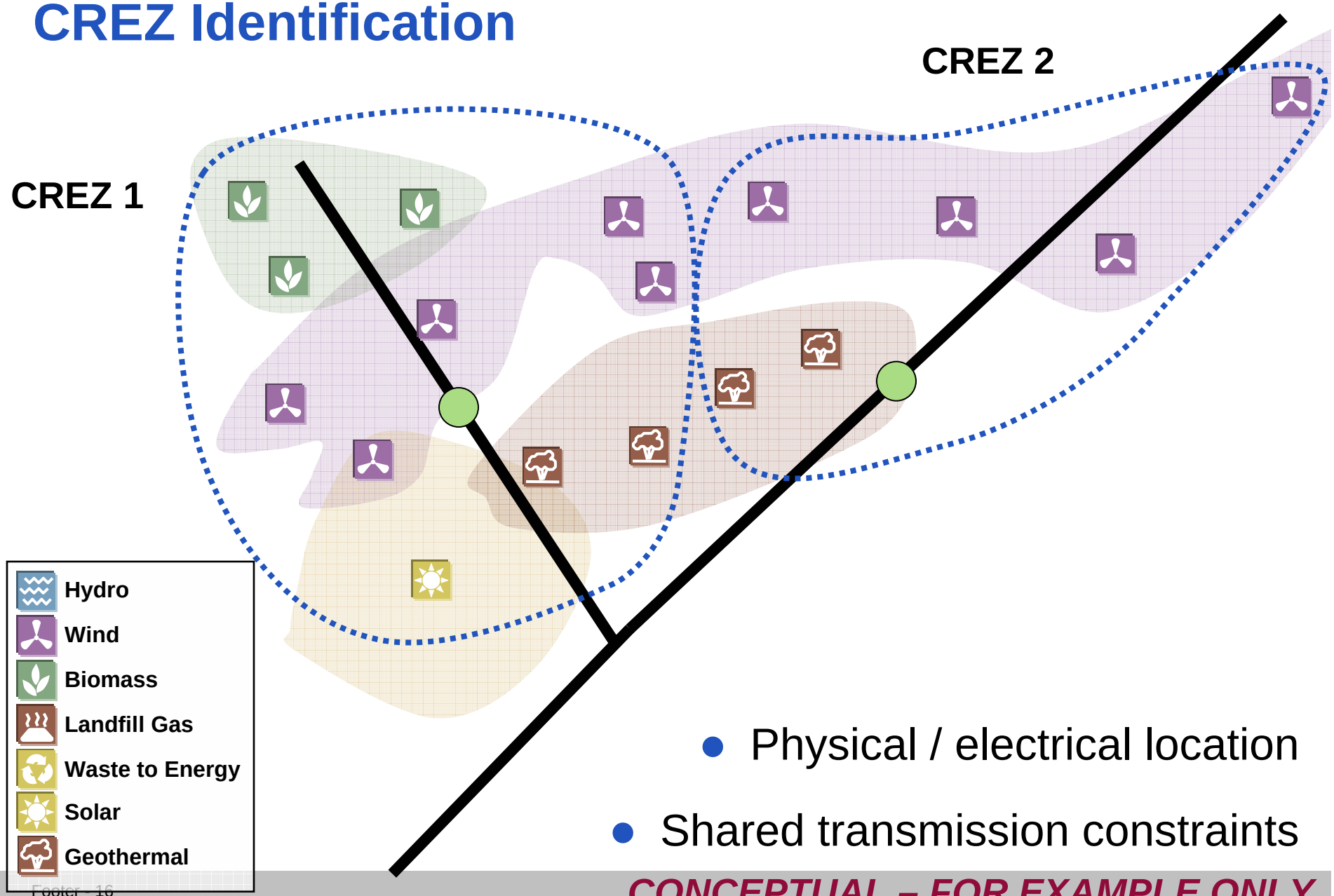

*CONCEPTUAL – FOR EXAMPLE ONLY*

# CREZ Identification - Projects




*CONCEPTUAL – FOR EXAMPLE ONLY*

# CREZ Identification

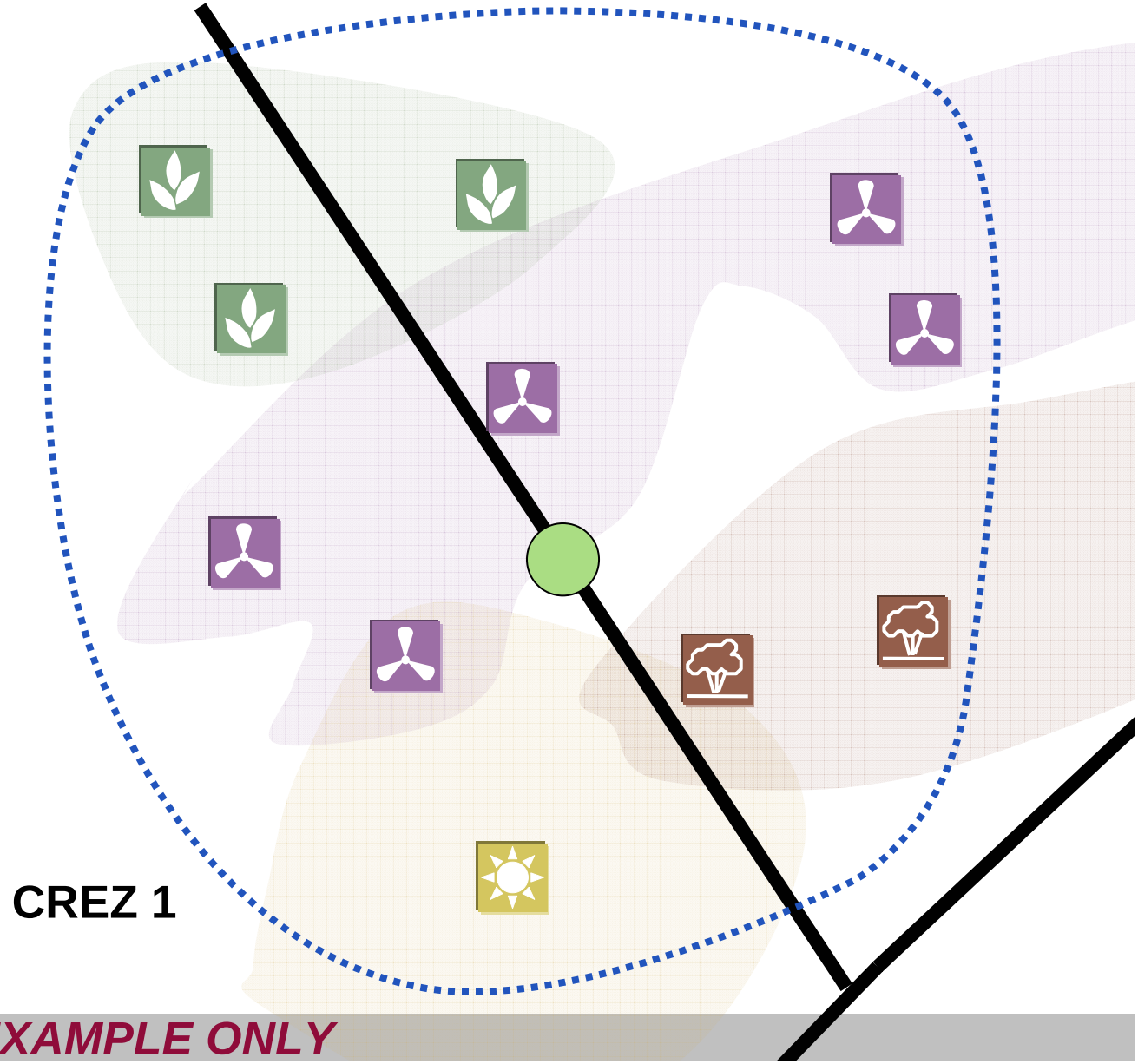



- Physical / electrical location
- Shared transmission constraints

***CONCEPTUAL – FOR EXAMPLE ONLY***

# Sub-CREZ Delineation

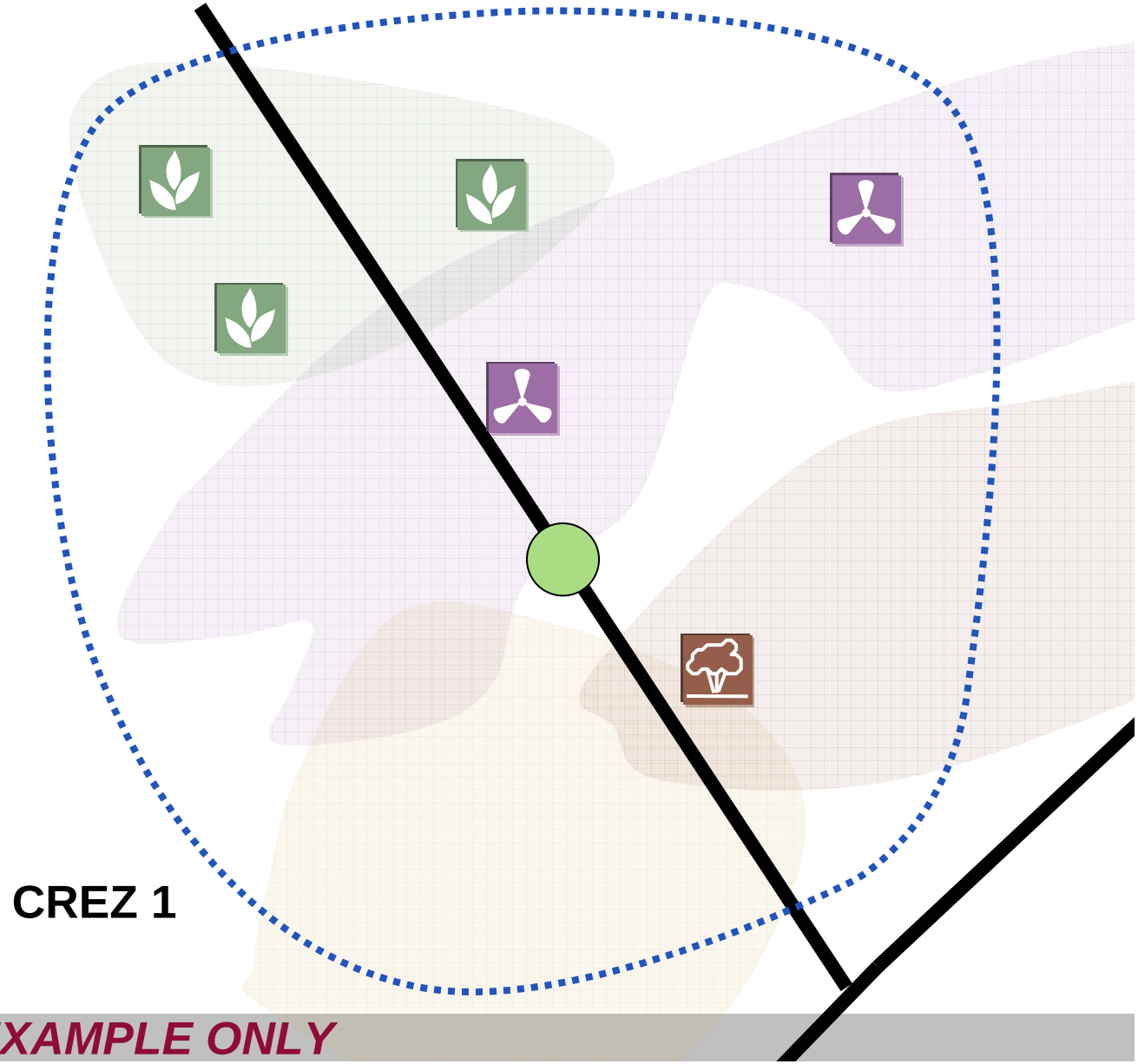
- Timeframe
- Economics




CONCEPTUAL – FOR EXAMPLE ONLY

# Sub-CREZ Delineation

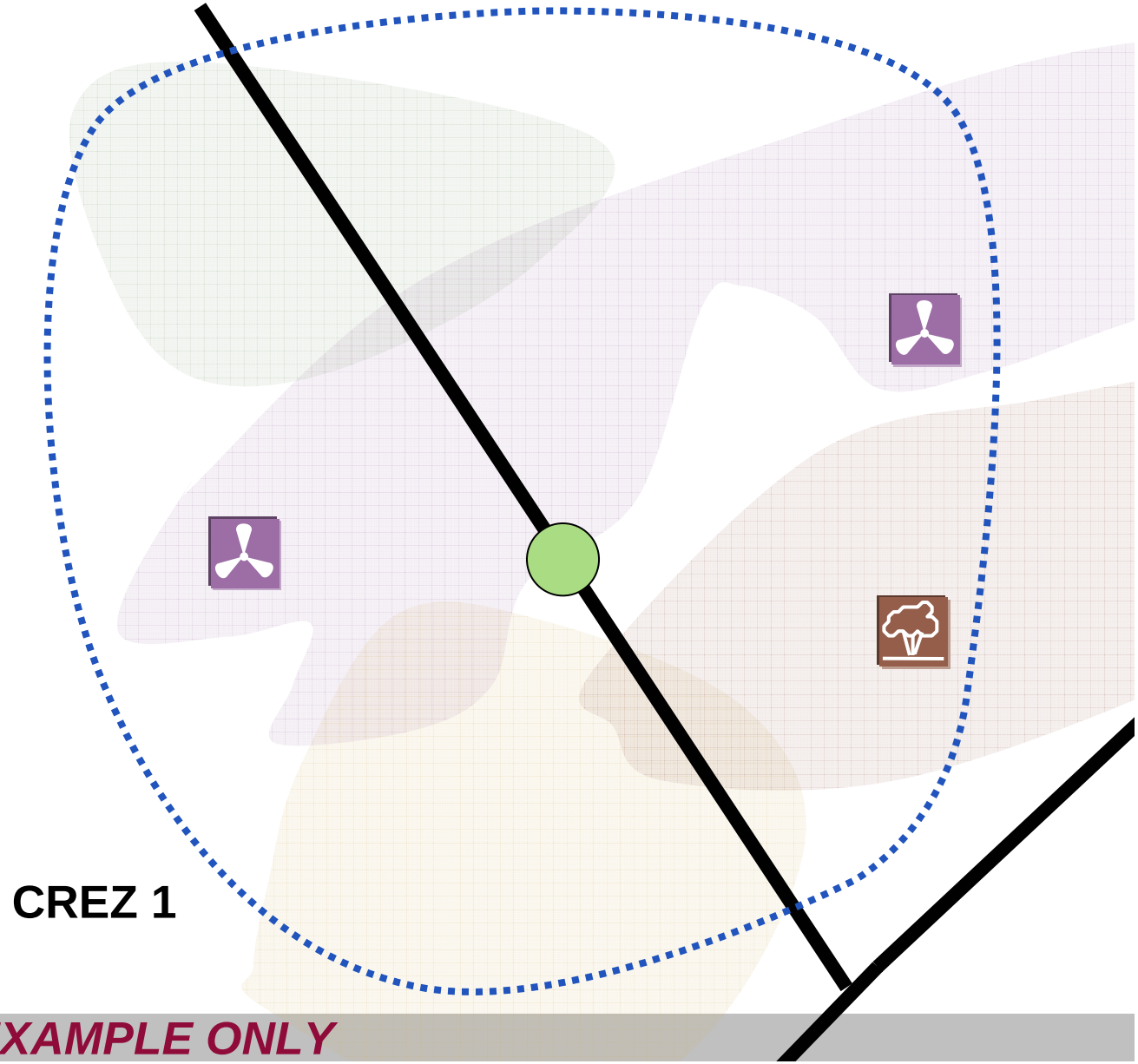
- Timeframe = **NEAR-TERM** (2013)




*CONCEPTUAL – FOR EXAMPLE ONLY*

# Sub-CREZ Delineation

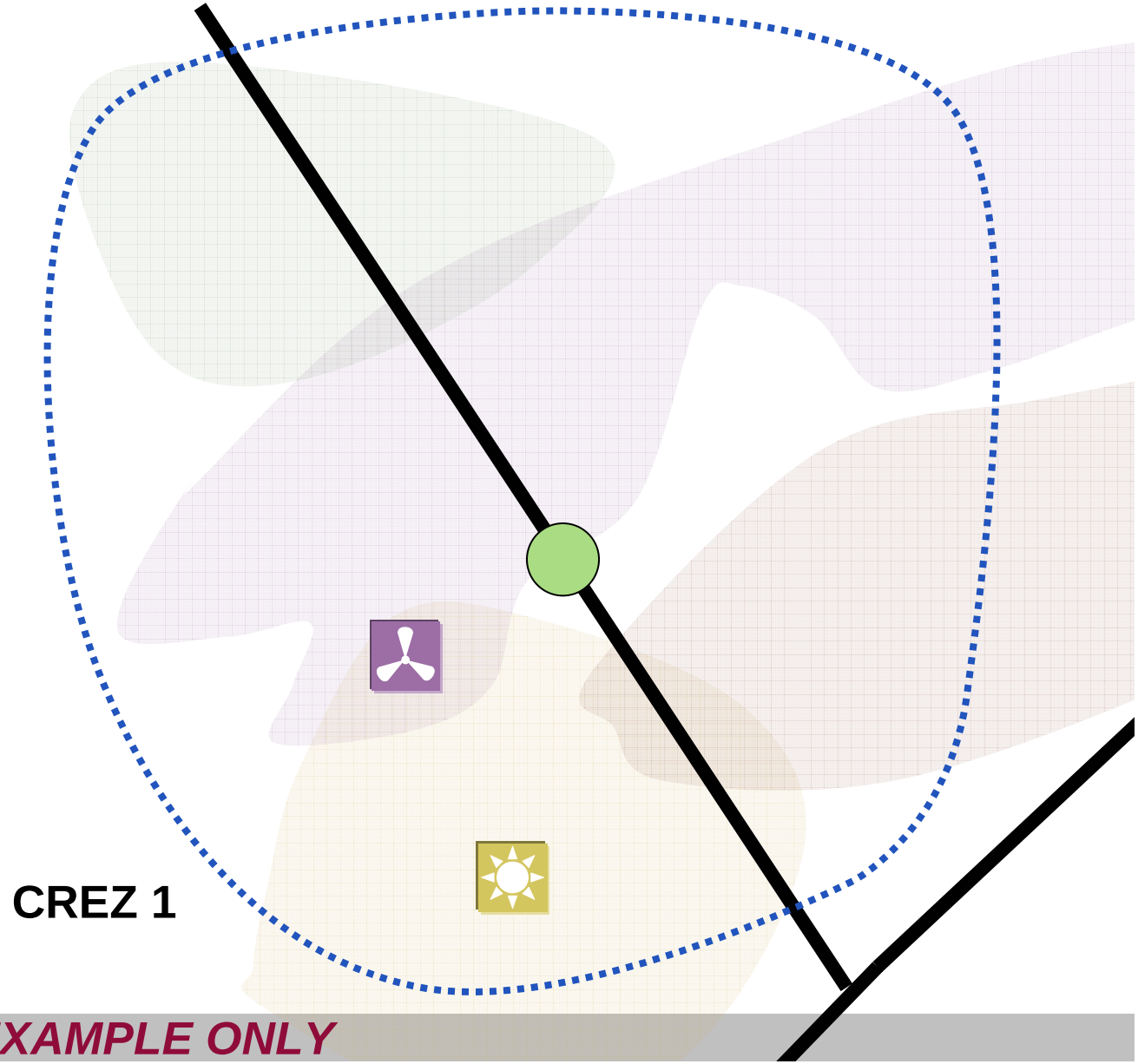
- Timeframe = **MID-TERM** (2014-2016)




*CONCEPTUAL – FOR EXAMPLE ONLY*

# Sub-CREZ Delineation

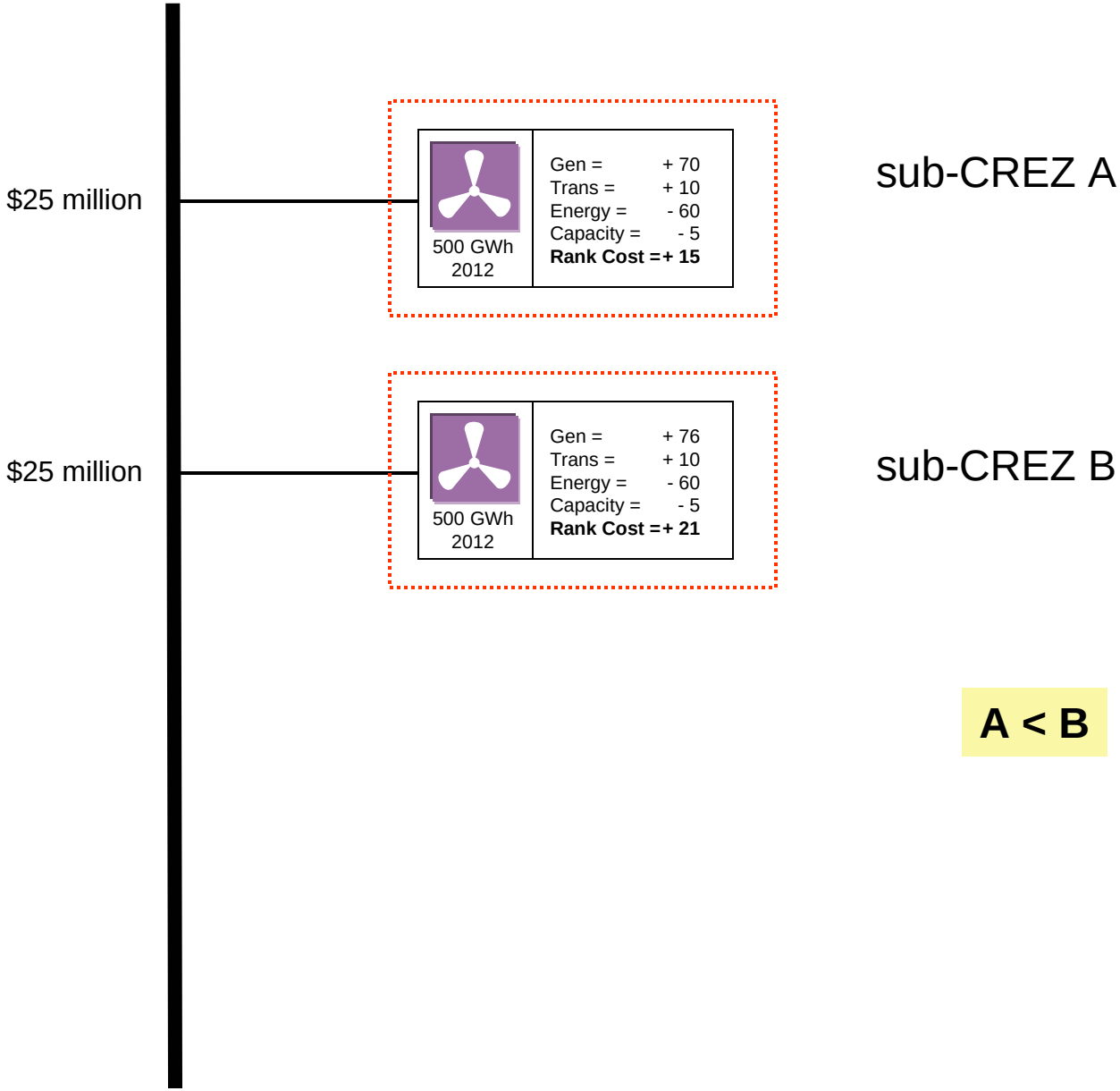
- Timeframe = **LONG-TERM** (2017-2020)



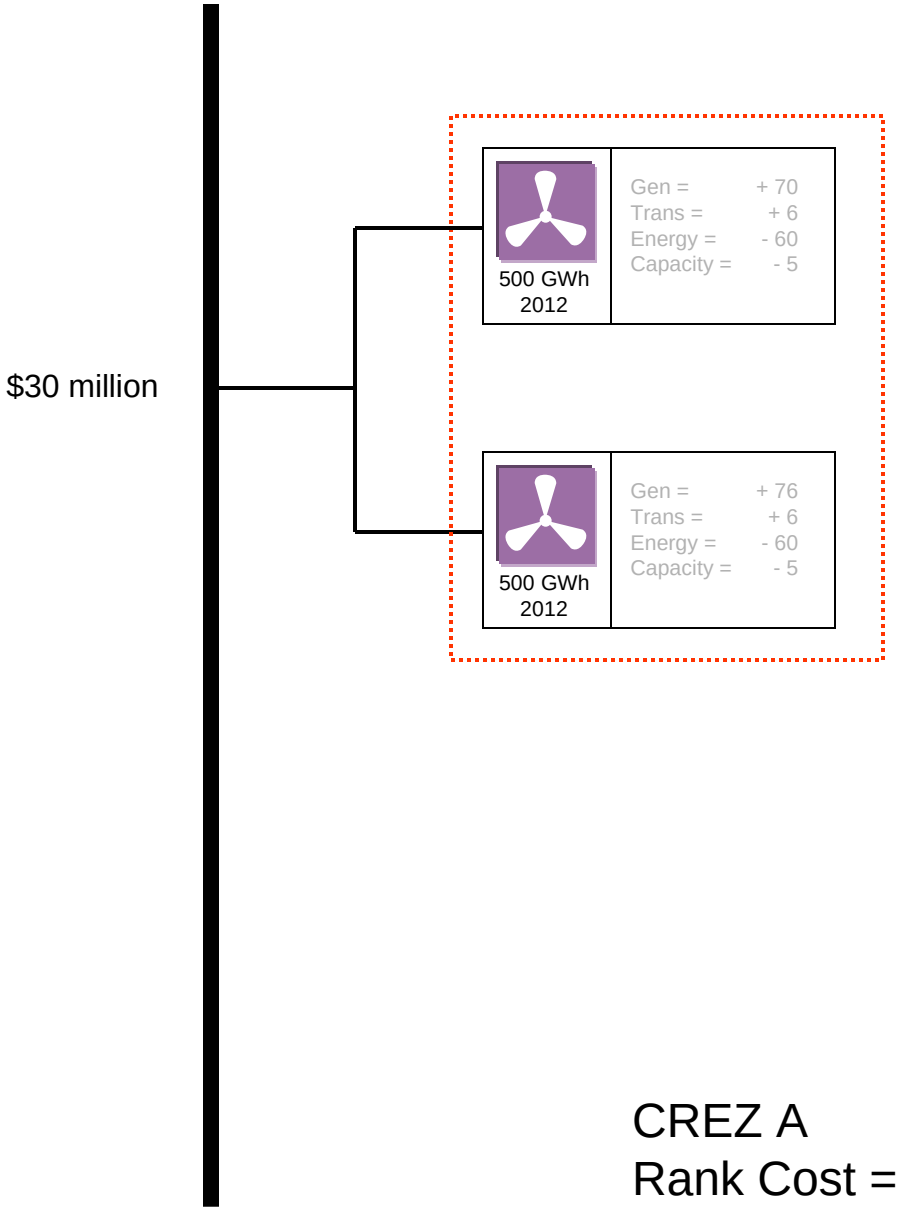

*CONCEPTUAL – FOR EXAMPLE ONLY*

# Principle of Additive Economics in Identifying Sub-CREZs

- If two or more projects have improved economics when they are pooled together, then the projects will be grouped as sub-CREZ
- If adding a project does not improve the economics of the collective sub-CREZ, then a new sub-CREZ will be formed for that project




CONCEPTUAL – FOR EXAMPLE ONLY




## Sub-CREZ C

| | |
|---|---|
| Gen = | + 73 |
| Trans = | + 6 |
| Energy = | - 60 |
| Capacity = | - 5 |
| **Rank Cost =** | **+ 14** |

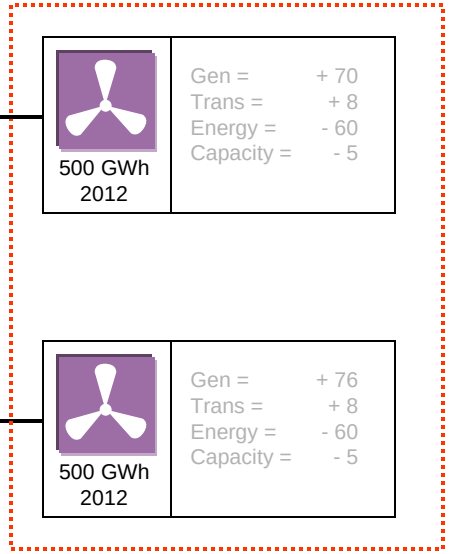
**C < A < B**

CREZ A
Rank Cost = 15

CREZ B
Rank Cost = 21

*CONCEPTUAL – FOR EXAMPLE ONLY*

$40 million




## Sub-CREZ C

| | |
|---|---|
| Gen = | + 73 |
| Trans = | + 8 |
| Energy = | - 60 |
| Capacity = | - 5 |
| **Rank Cost =** | **+ 16** |

**A < C < B**

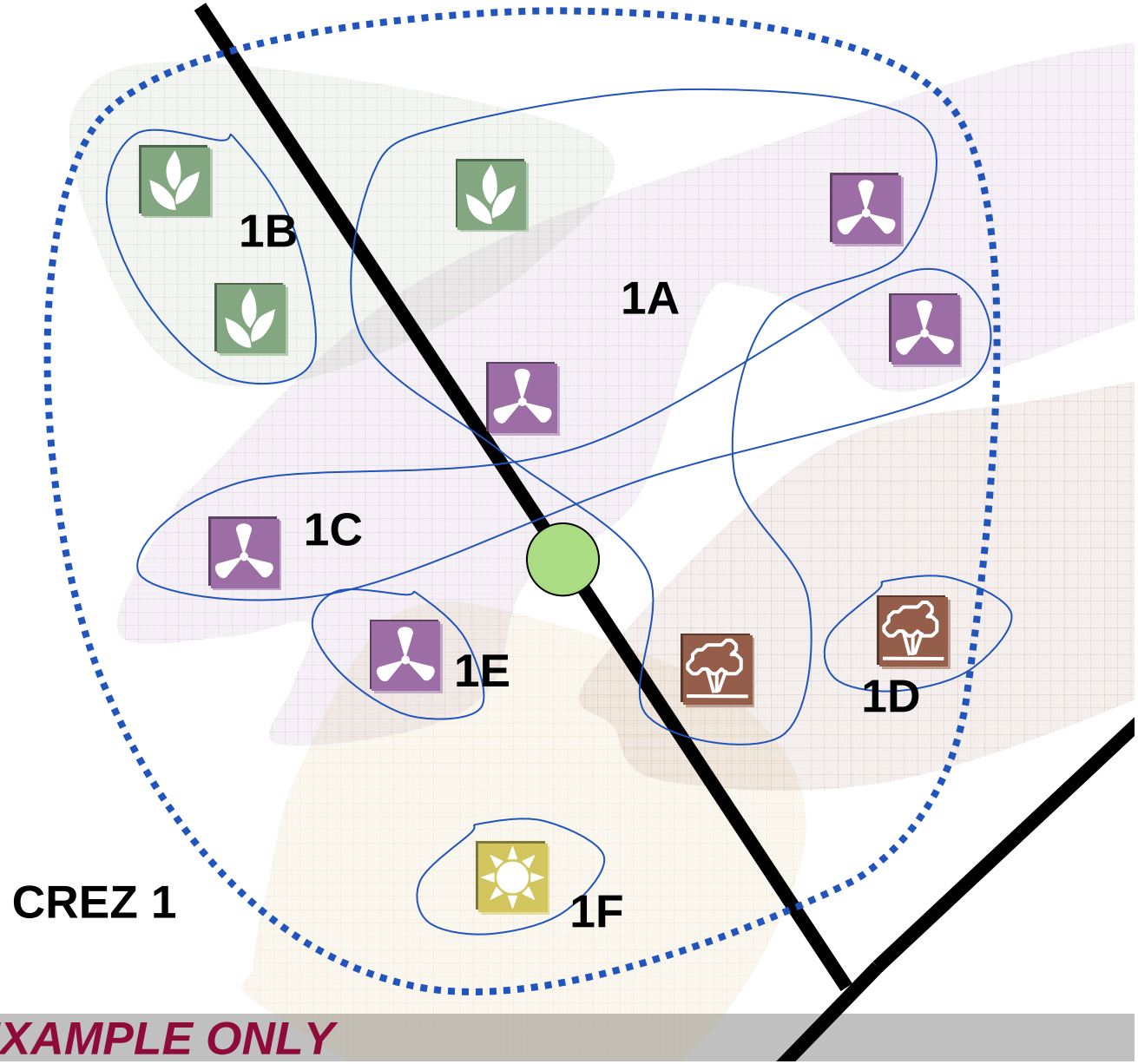
CREZ A
Rank Cost = 15

CREZ B
Rank Cost = 21

*CONCEPTUAL – FOR EXAMPLE ONLY*

# Sub-CREZ Delineation

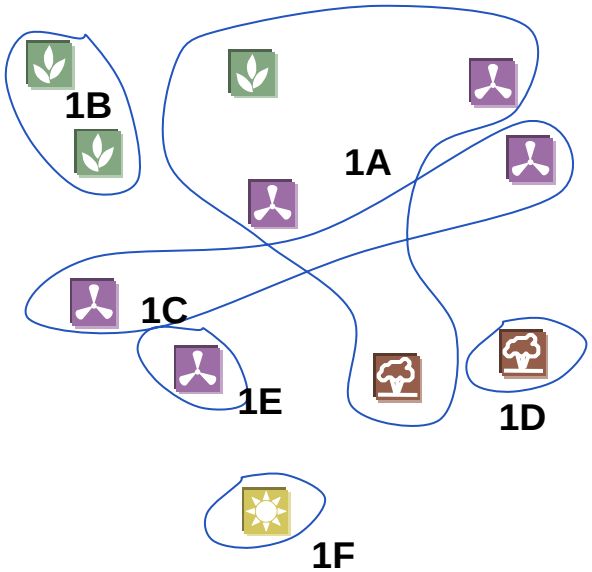
- Timeframe + Economics




*CONCEPTUAL – FOR EXAMPLE ONLY*

# CREZ Characterization and Ranking

- Sub-CREZ characteristics will be developed based on constituent projects




| | Timeframe | Annual Generation (GWh) | | | | Resource Valuation (2008$/MWh) | | | | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|
| | Available | Wind | Geo | Solar | Bio | Gen | Trans. | Energy | Capacity | Cost |
| CREZ 1A | Near | 600 | 300 | | 350 | 80 | 7 | 73 | 9 | 5 |
| CREZ 1B | Near | | | | 600 | 97 | 10 | 75 | 13 | 20 |
| CREZ 1C | Mid | 500 | | | | 80 | 15 | 70 | 6 | 19 |
| CREZ 1D | Mid | | 250 | | | 95 | 15 | 75 | 13 | 23 |
| CREZ 1E | Long | 400 | | | | 84 | 15 | 70 | 6 | 23 |
| CREZ 1F | Long | | | 700 | | 140 | 20 | 100 | 22 | 38 |

# CREZ Characterization and Ranking

1. All potential sub-CREZs in a given time period will be compared
2. The needed RPS demand for that period will be identified
3. The lowest cost sub-CREZs will be built until demand is met

# CREZ Characterization and Ranking

| | Timeframe | Annual Generation (GWh) | | | | Resource Valuation (2008$/MWh) | | | | Ranking |
|---|---|---|---|---|---|---|---|---|---|---|
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|---|---|---|---|---|---|---|---|---|---|---|
| | Available | Wind | Geo | Solar | Bio | Gen | Trans. | Energy | Capacity | Cost |
| CREZ 2A | Near | 500 | | | | 65 | 0 | 70 | 6 | -11 |
| CREZ 2B | Mid | 350 | | | | 87 | 10 | 70 | 6 | 21 |
| CREZ 2C | Mid | 300 | 250 | | | 98 | 25 | 72 | 9 | 41 |
| CREZ 2D | Mid | | 150 | | | 100 | 35 | 75 | 13 | 47 |

# CREZ Characterization and Ranking

## If Near-term demand is 1500 GWh/yr, then build the following:

| | Timeframe | Annual Generation (GWh) | | | | Resource Valuation (2008$/MWh) | | | | Ranking |
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# Renewable Technology-Specific Assumptions

| | |
|---|---|
| Biomass | Hydro |
| Landfill Gas | Solar Photovoltaic |
| Anaerobic Digestion | Solar Thermal |
| Geothermal | Marine Current |
| Wind – On-shore | Wave |
| Wind – Off-shore | |

# What are Technology Characteristics?

- Major distinguishing assumptions that determine project economics
- Cost and performance information derived from recent Black & Veatch projects and public sources
- ***Typical, representative information provided***
- Characteristics can vary widely
  - Project Size
  - Project location
  - Labor type
  - Air quality requirements
  - Fuel variations

# Goal of Technology Characterization

- Phase 1A:
  - Provide broad indication of general technology costs
  - Used to screen entire technology categories
- Phase 1B:
  - Develop project-specific estimates
  - Used for developing and ranking CREZs
  - The specific estimates in Phase 1B should be relatively consistent with Phase 1A ranges

# Technology Characteristics

- Technology type
- Technology development status (commercial, R&D, etc.)
- Net capacity (MW)
- Net capacity factor (percent)
- Total project capital cost ($/kW)
  - Engineer-Procure-Construct
  - Owner's Cost
  - Transmission Cost (separately considered)

# Technology Characteristics (cont.)

- Fixed operations and maintenance cost
- Variable operations and maintenance cost
- Operations and maintenance escalation
- Fuel cost ($/MBtu)
- Fuel cost escalation
- Net plant heat rate (efficiency)

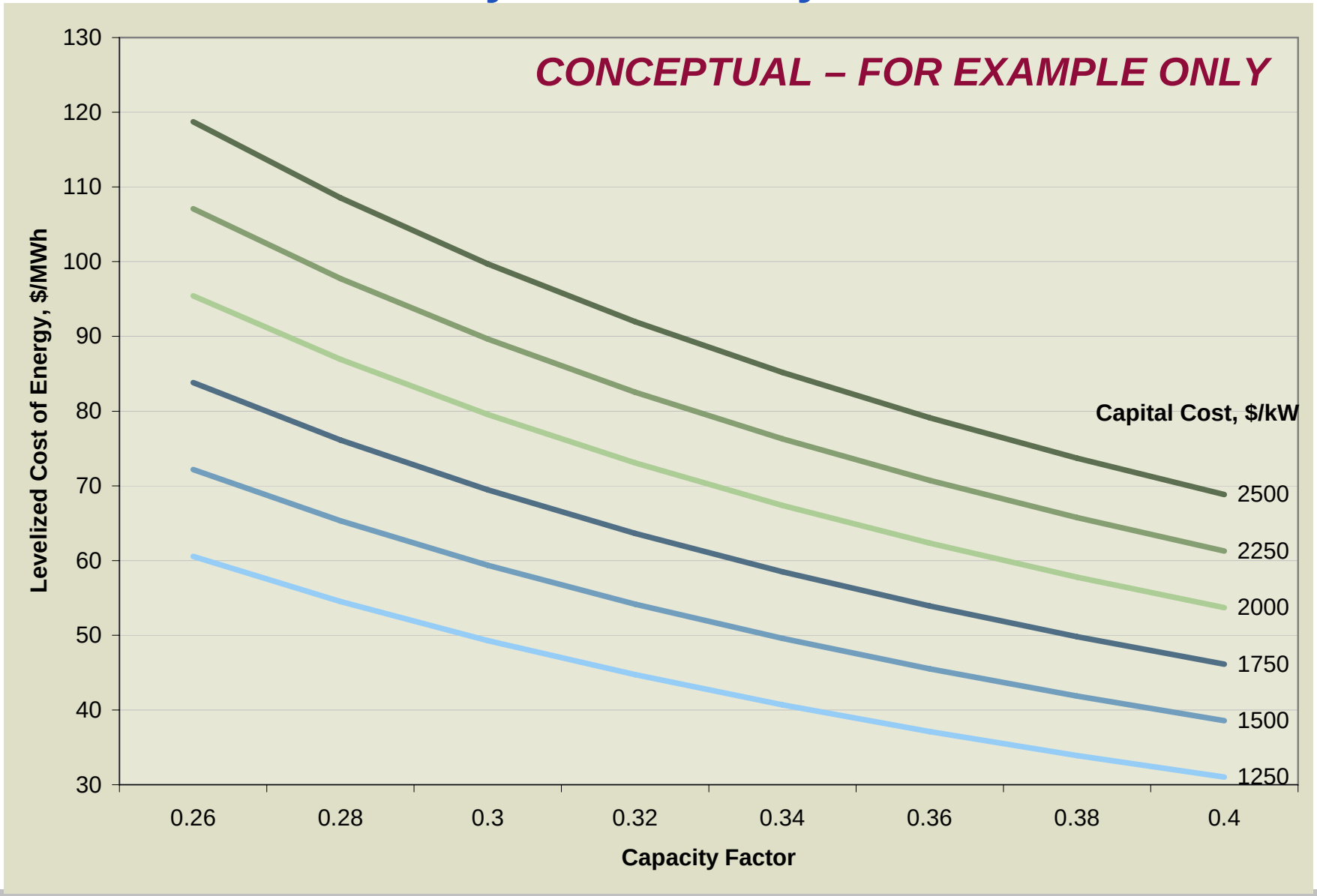
# Overall Assumptions – Definitions

- All costs are screening level and presented in 2008$
- Capital costs based on an engineering, procurement and construction (EPC) method of contracting
- Capital costs are based on current market conditions – volatile
  - 20% increase in last 6 months
  - 27% increase in last 12 months
  - 130% increase over year 2000
    - *Source:* Power Capital Costs Index, IHS Inc. and Cambridge Energy Research Associates

# On-shore Wind

| | |
|---|---|
| Net Capacity, MW | 100 |
| Total Capital Cost, $/kW | 1,900 – 2,400 |
| Capacity Factor, % | 25 - 40 |
| FOM, $/kW-yr | 50 |
| VOM, $/MWh | – |

# Economics of Wind Vary Substantially






Source: Black & Veatch

# Off-shore Wind – Pacific Ocean

| | |
|---|---|
| Net Capacity, MW | 200 |
| Total Capital Cost, $/kW | 5,000 to 6,000 |
| Capacity Factor, % | 35 - 45 |
| FOM, $/kW-yr | 75-100 |
| VOM, $/MWh | – |

# Stand-alone Biomass

| | |
|---|---|
| Net Capacity, MW | 35 |
| Capacity Factor, % | 80 |
| Net Plant Heat Rate, Btu/kWh | 14,500 |
| Fuel Cost, $/MBtu | 0-3.00 |
| Total Capital Cost, $/kW | 3,000-5,000 |
| FOM, $/kW-yr | 83 |
| VOM, $/MWh | 11 |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# Landfill Gas

| | |
|---|---|
| Net Capacity, MW | 5 |
| Capacity Factor, % | 80 |
| Net Plant Heat Rate, Btu/kWh | 13,500 |
| Fuel Cost, $/MBtu | 1-2 |
| Total Capital Cost, $/kW | 1,200-2,000 |
| FOM, $/kW-yr. | – |
| VOM, $/MWh | 17 |


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# Geothermal

| | |
|---|---|
| Net Capacity, MW | 30 |
| Total Capital Cost, $/kW | 3,000-5,000 |
| Capacity Factor | 70% - 90% |
| FOM, $/kW-yr | – |
| VOM, $/MWh | 25-30 |

# Solar PV *(Southwest US Location)*

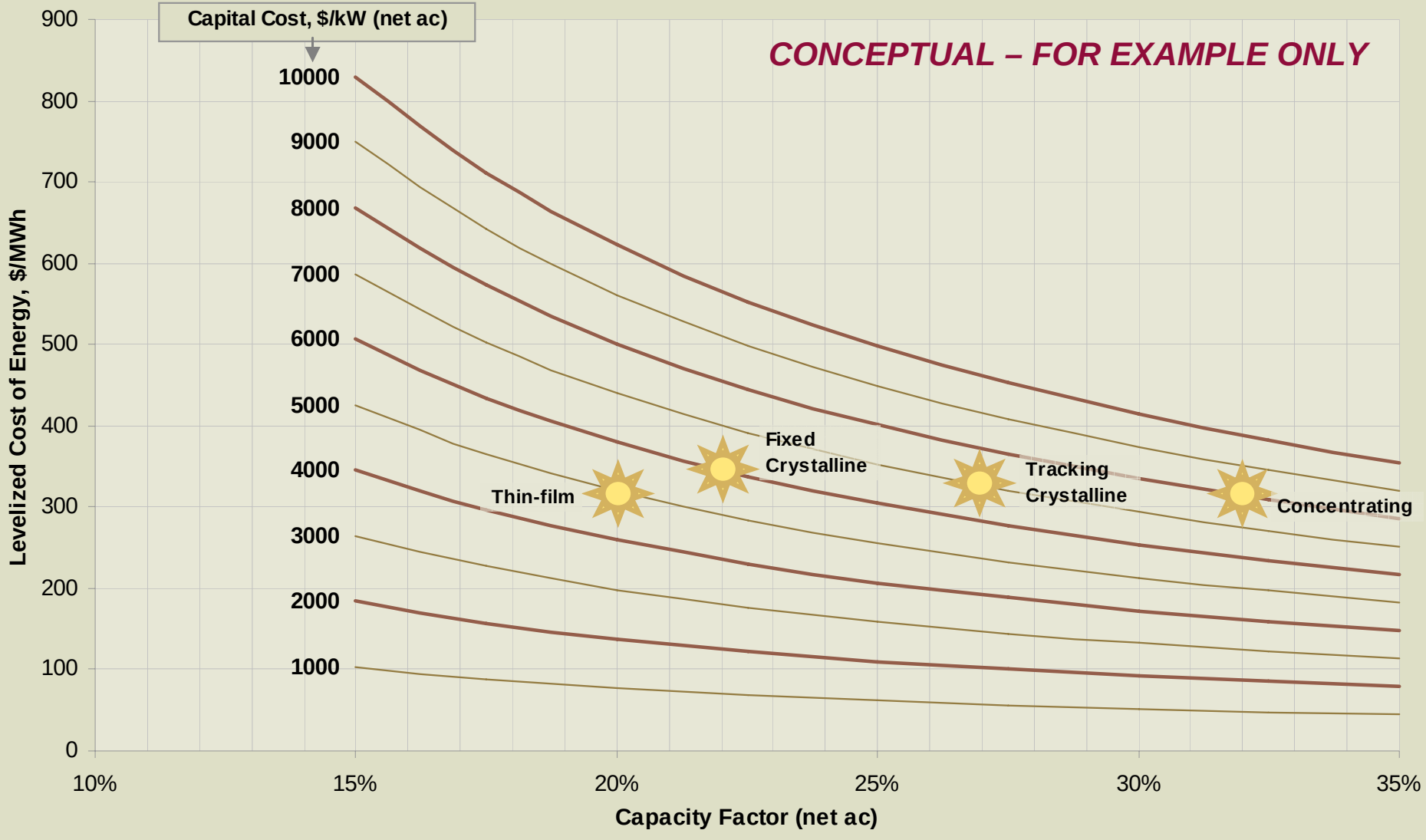
All values based on net AC rating
Based on Crystalline, Tracked

| | |
|---|---|
| Net Capacity, MW | 20 |
| Total Capital Cost, $/kW | 6,500-7,500 |
| Capacity Factor, % | 25-30% |
| FOM, $/kW-yr | 35 |
| VOM, $/MWh | – |

# Current Cost of Solar PV Technologies

**Assuming installation in New Mexico**

**No tax incentives, $25/kW-yr O&M, 10.6% levelized fixed charge rate**



# Solar Thermal *(Southwest US Location)*

Based on Parabolic Trough, No Storage

| | |
|---|---|
| Net Capacity, MW | 200 |
| Total Capital Cost, $/kW | 3600 - 4300 |
| Capacity Factor, % | 26 - 29 |
| FOM, $/kW-yr | 66 |
| VOM, $/MWh | – |



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# Thank You!


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