

# CONNECTION AVAILABILITY - T&D SYSTEM

Renewable IPP Developer's Day  
November 17, 2016



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# OUTLINE

## Purpose

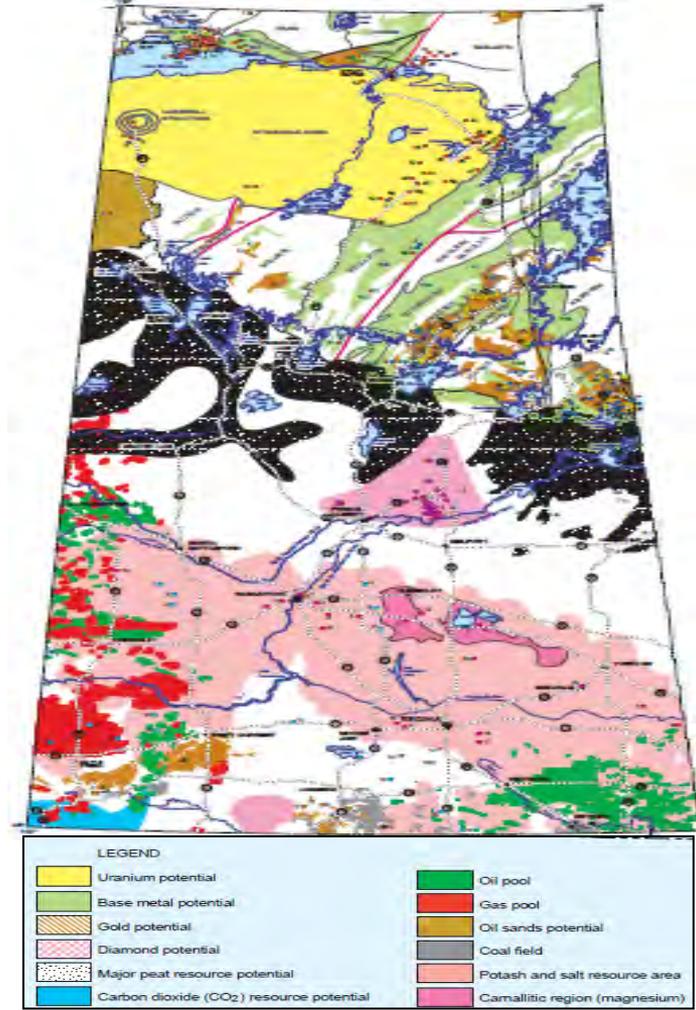
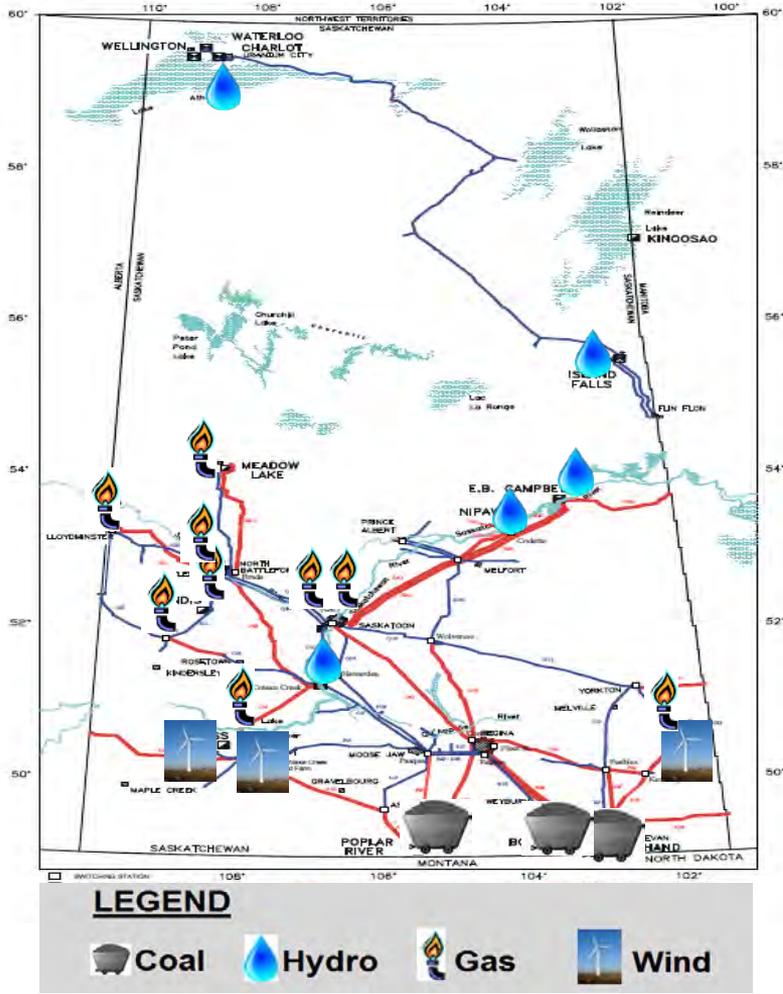
- Facilitate IPP suppliers
  - Provide information on our Transmission System plan
  - Provide drivers for interconnection costs & examples
  - Provide general information on interconnection process
  - Answer questions

## Agenda

- Drivers for Transmission System Investment
- Transmission System Development Plan
- Interconnection Costs
- Examples
- Transmission & Interconnection Planning Process

# Drivers for Transmission System Development



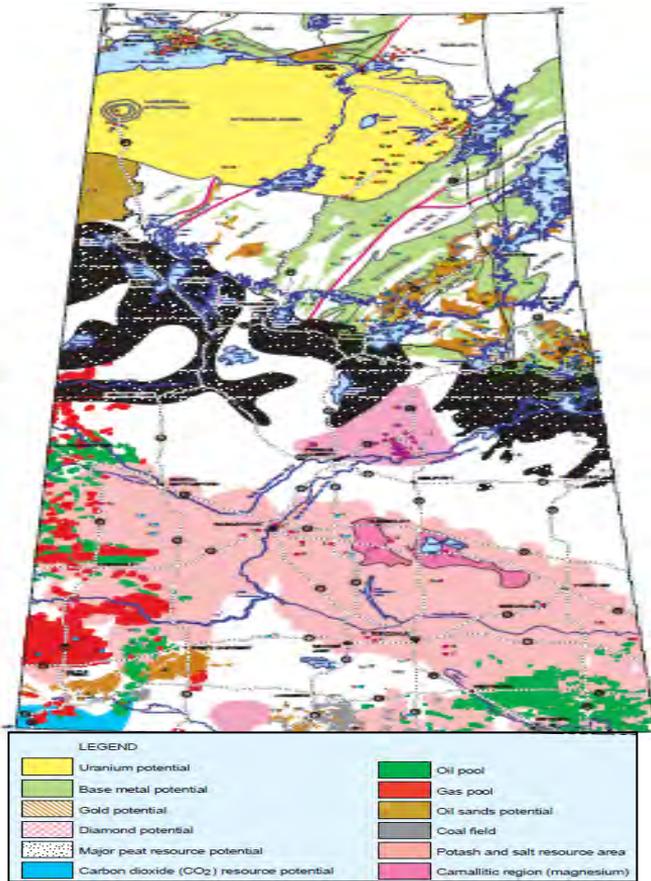


Transmission is built to deliver power & energy to the load, and integrate generation.

# DRIVERS FOR INVESTMENT

- Growth in the large industrial load sector
- General provincial load growth
- Changes to generation (additions and retirements)
- Infrastructure sustainment
- Compliance with regulatory / reliability standards
- Open Access Transmission Tariff (OATT)

# DRIVERS - LOAD



Resource-based economy

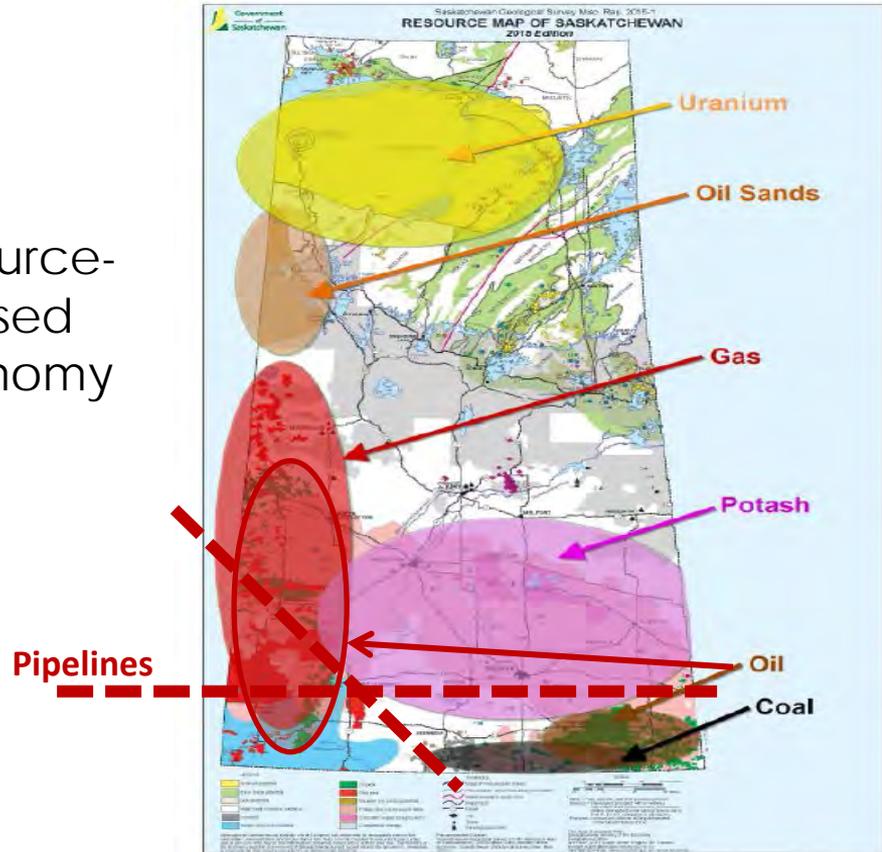
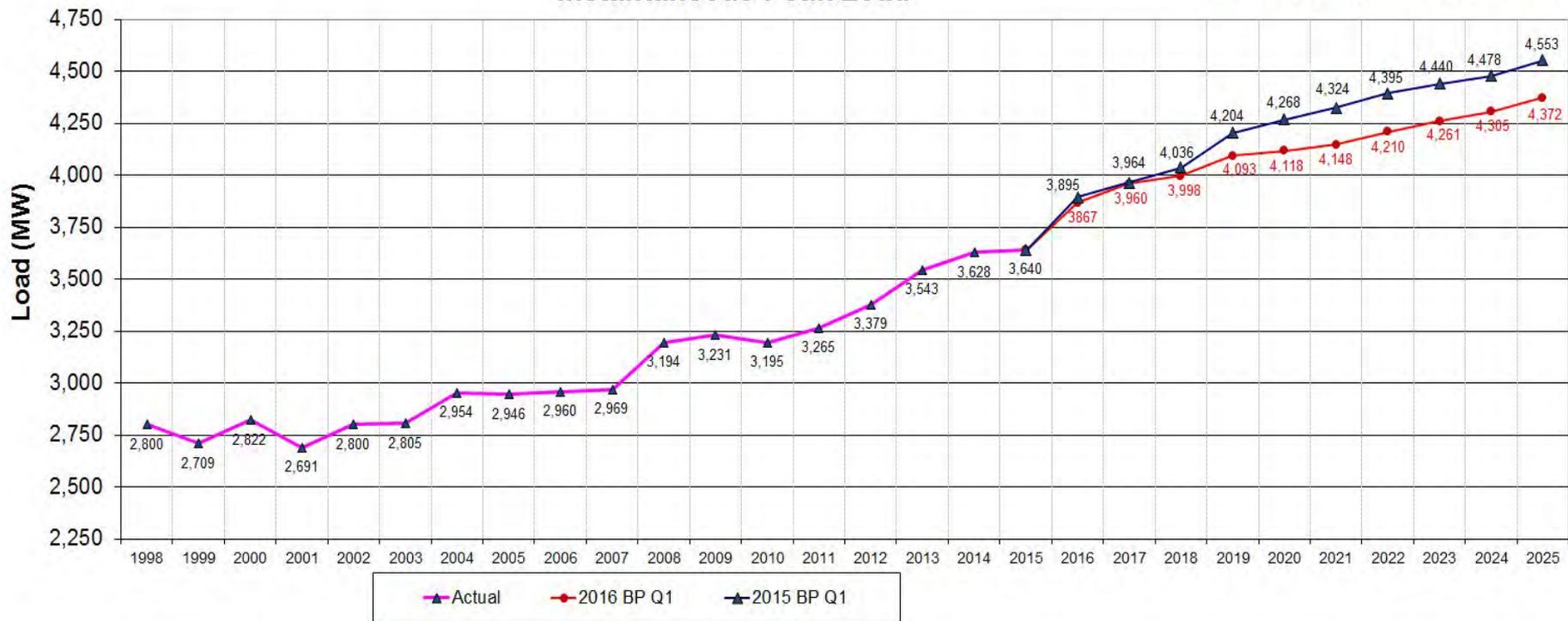


Figure 3: Saskatchewan Mineral Resources

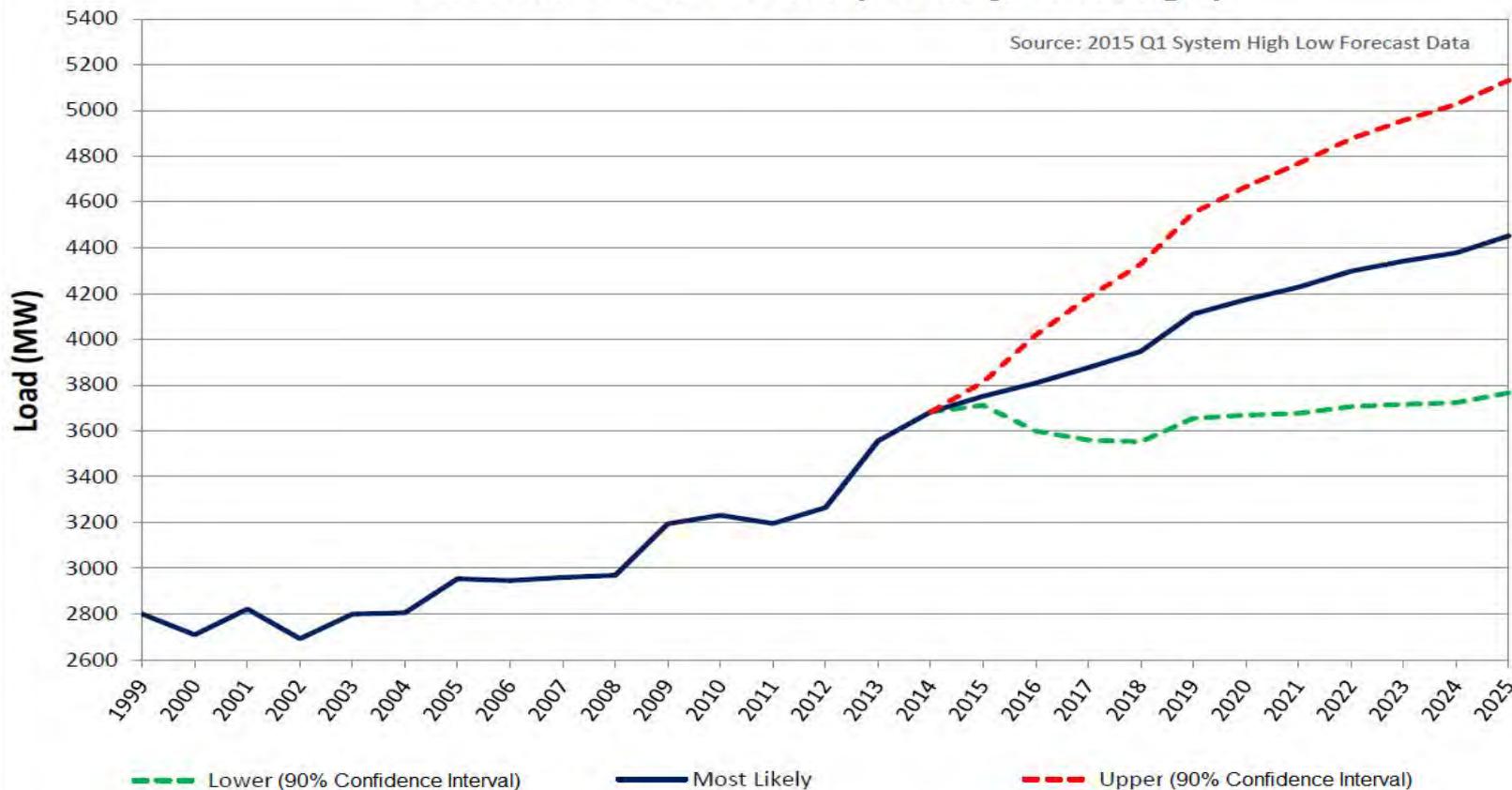
# Instantaneous Peak Load

Sources: 2016 Q1 System Forecast, 2015 Q1 System Forecast

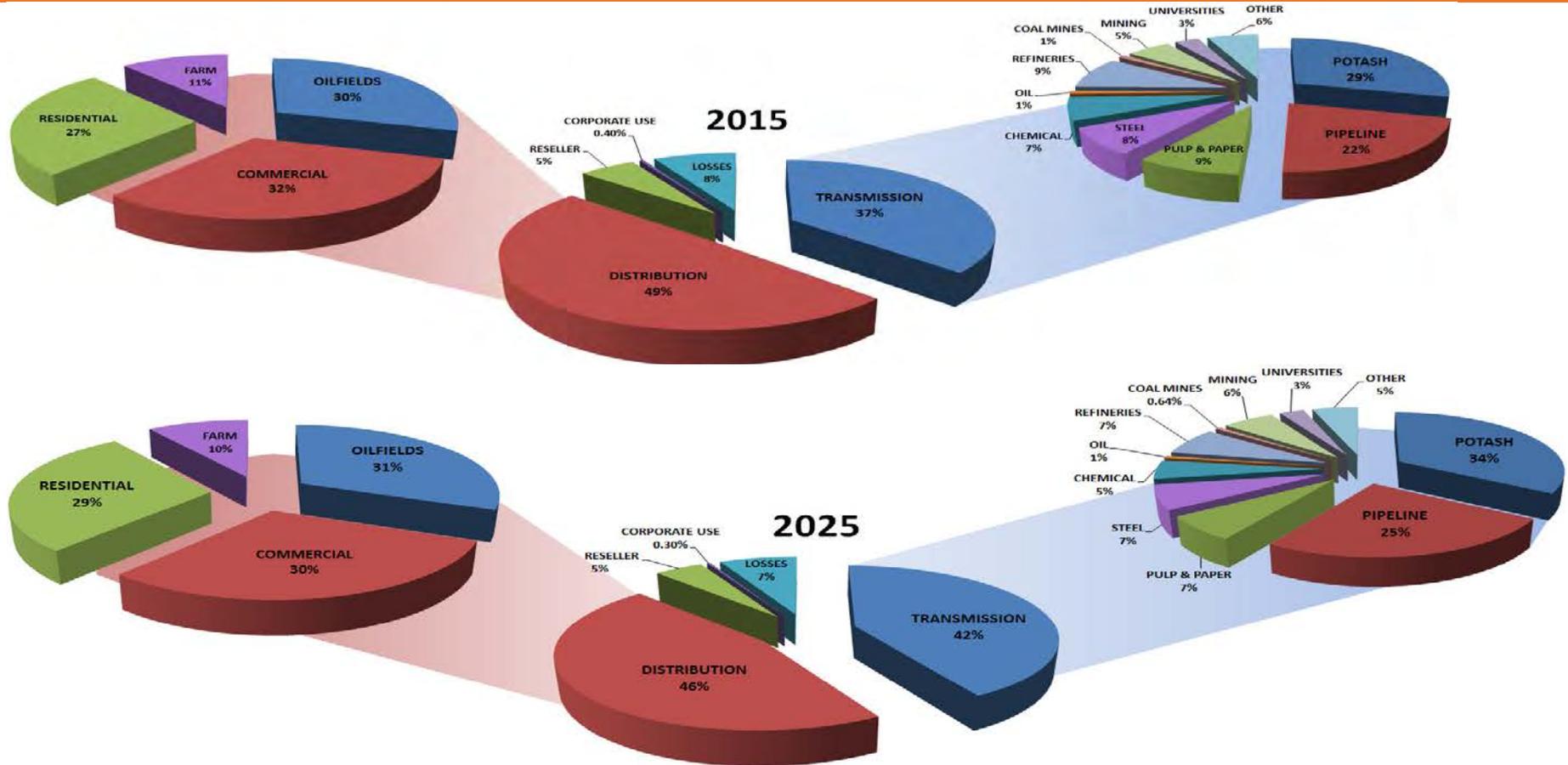


# Interval Peak Load (Hourly Average)

Source: 2015 Q1 System High Low Forecast Data



# LOAD GROWTH – DETAILS



# DRIVERS - GENERATION

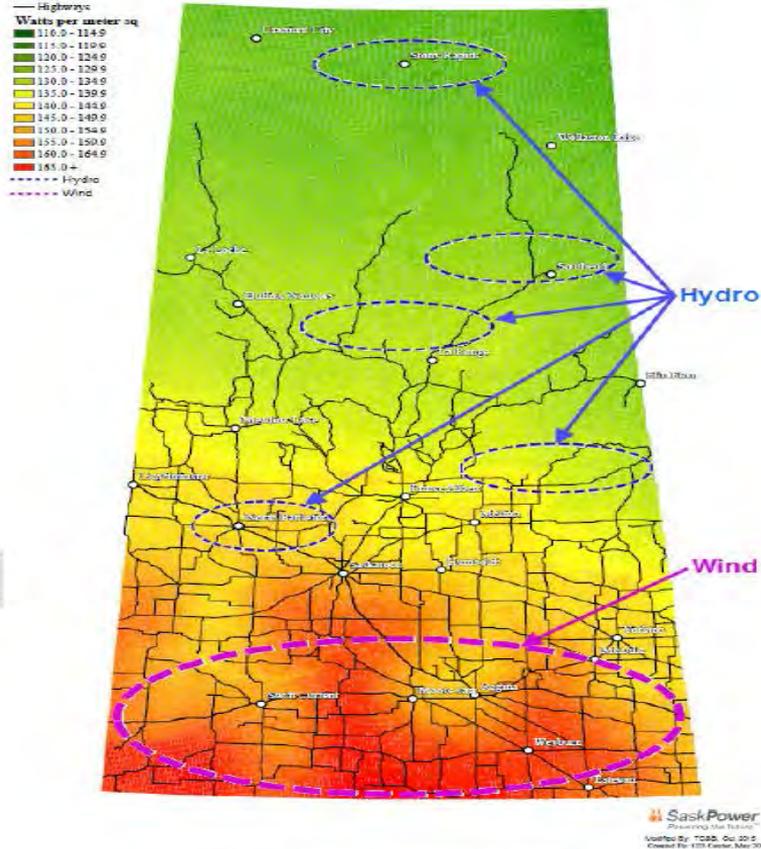
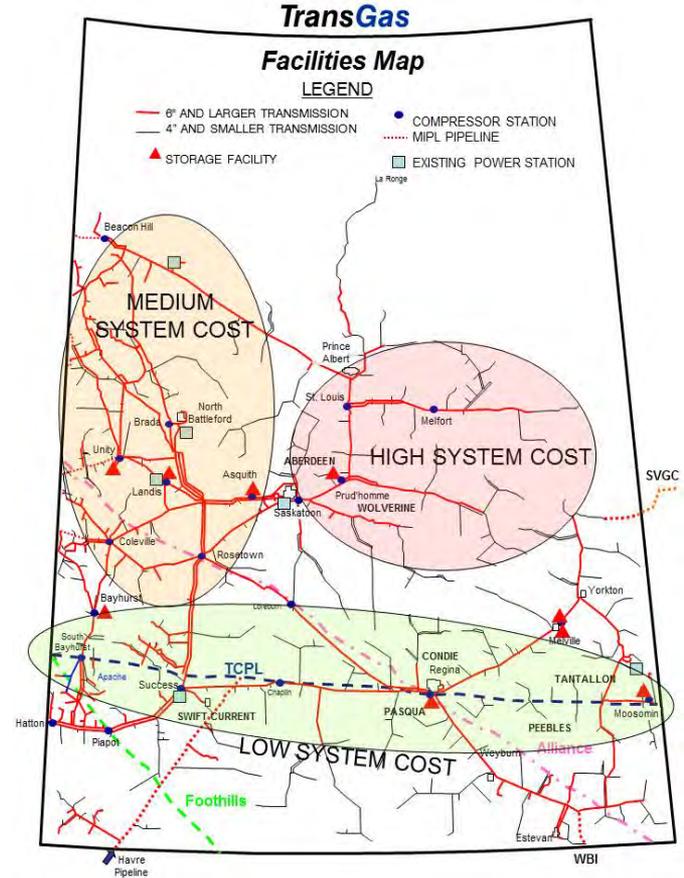


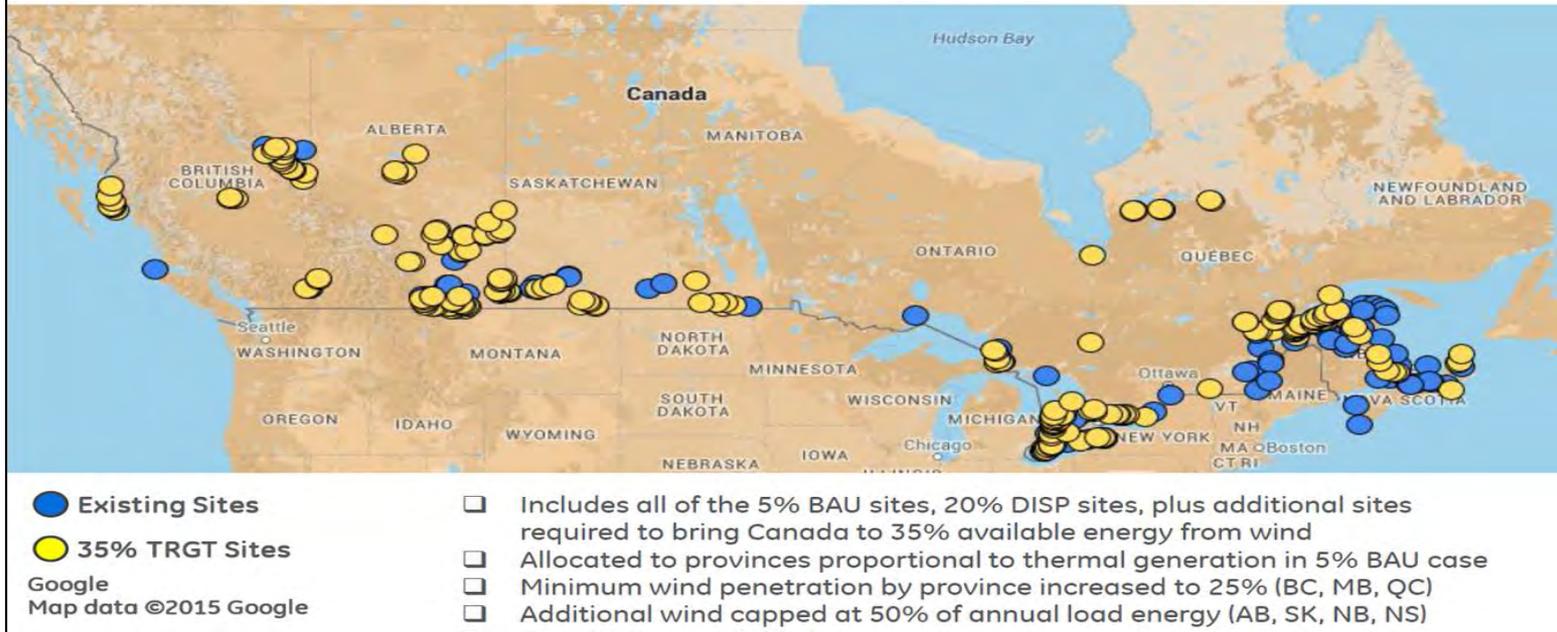
Figure 4: Saskatchewan Wind/Hydro/Solar Map



# WIND - POSSIBLE FUTURE

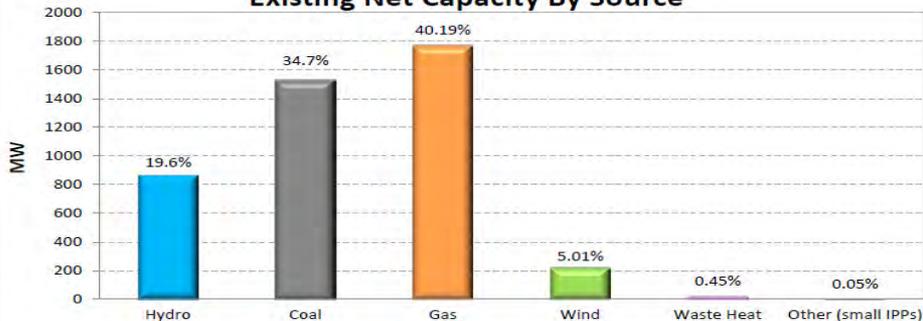
- Pan-Canadian Wind Study – Targeted Penetration

## 35% TRGT Scenario Site Selection



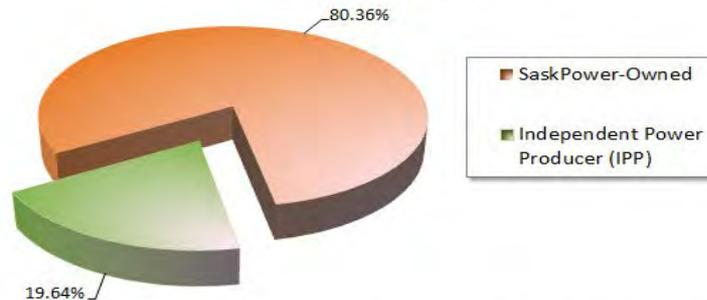
# CAPACITY MIX - EXISTING

## Existing Net Capacity By Source



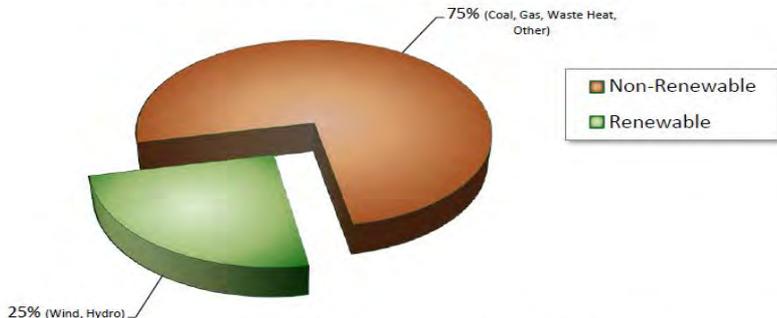
Sources: SaskPower 2014 Annual Report, SaskPower Ten Year Supply Plan (2016 - 2025)

## SPC vs. IPP Generation



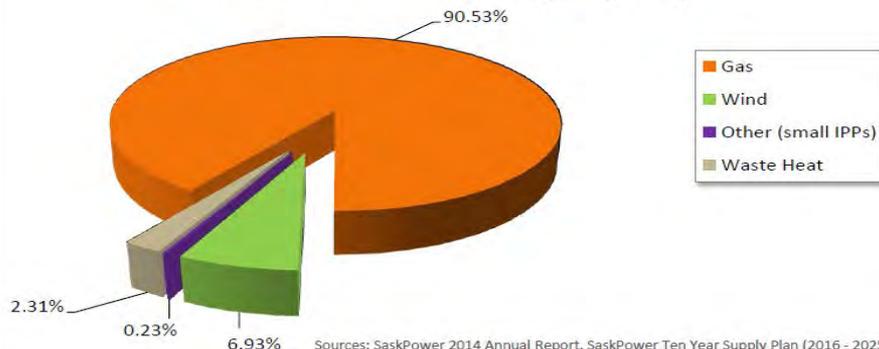
Sources: SaskPower 2014 Annual Report, SaskPower Ten Year Supply Plan (2016 - 2025)

## Renewable vs. Non-Renewable Contribution



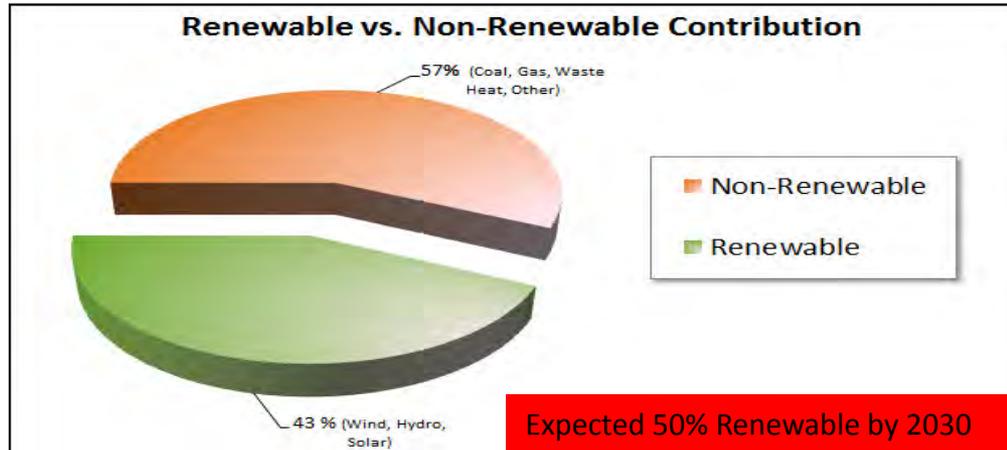
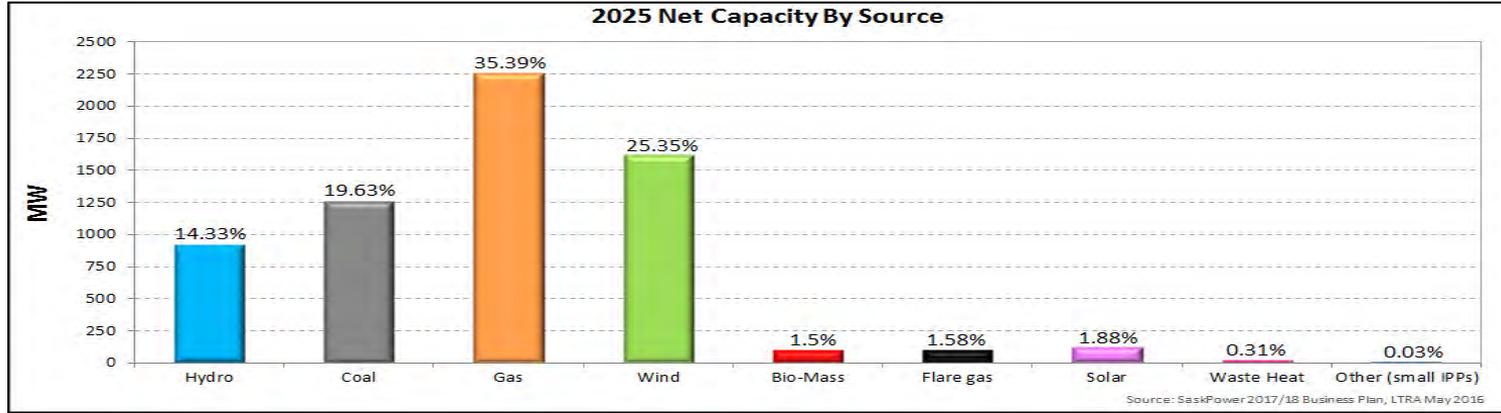
Sources: SaskPower 2014 Annual Report, SaskPower Ten Year Supply Plan (2016 - 2025)

## IPP Contribution to Existing Capacity



Sources: SaskPower 2014 Annual Report, SaskPower Ten Year Supply Plan (2016 - 2025)

# CAPACITY MIX - 2025



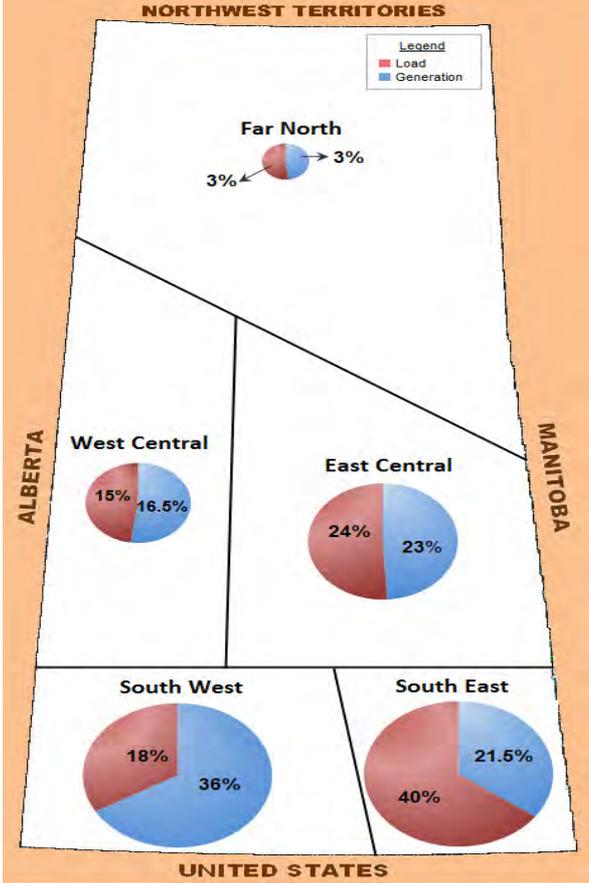
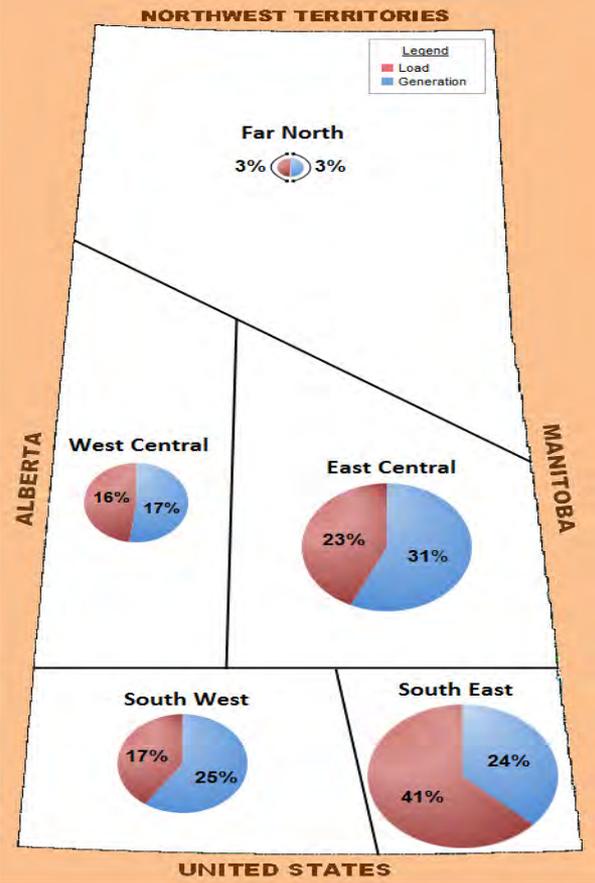


# Transmission System Development

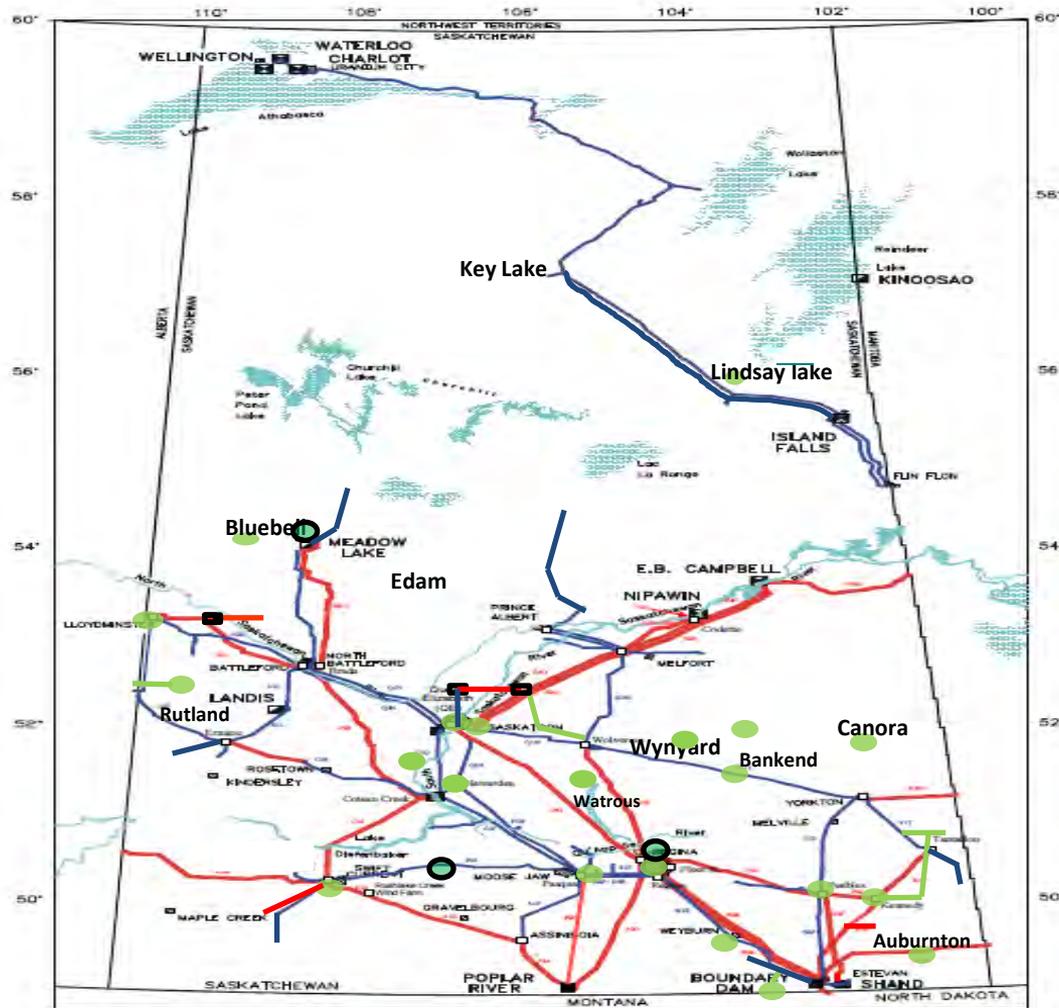


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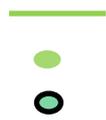
# REGIONAL GENERATION CAPACITY & PEAK LOAD







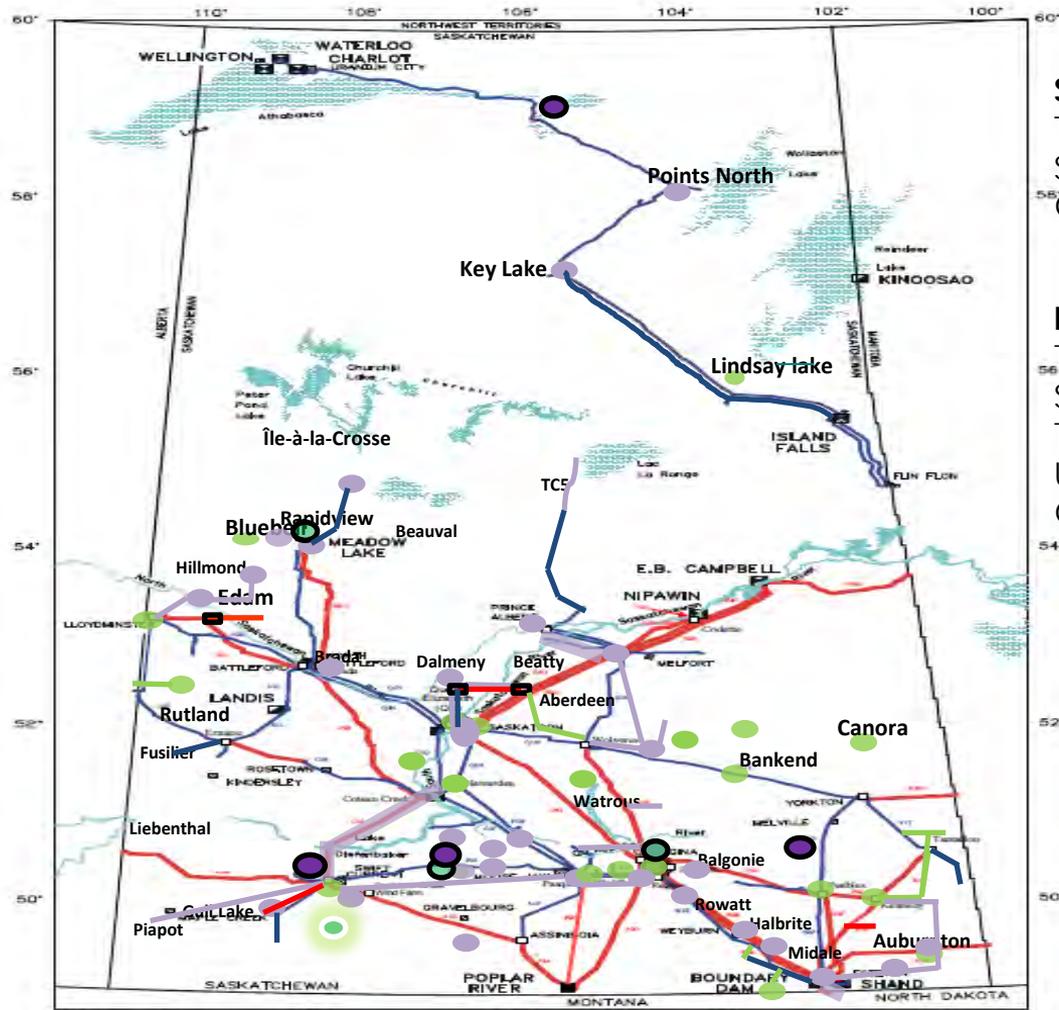
Short Term  
Transmission line  
Station  
Generation



- SWITCHING STATION
- HYDRO GENERATING SITE
- THERMAL GENERATING SITE
- INTERNAL COMBUSTION GENERATING SITE



- 230 kV TRANSMISSION LINES
- 138 kV TRANSMISSION LINES



### Short Term

Transmission line



Station



Generation



### Medium Term

Transmission Line



Station



Transmission Line



Upgrade



Generation

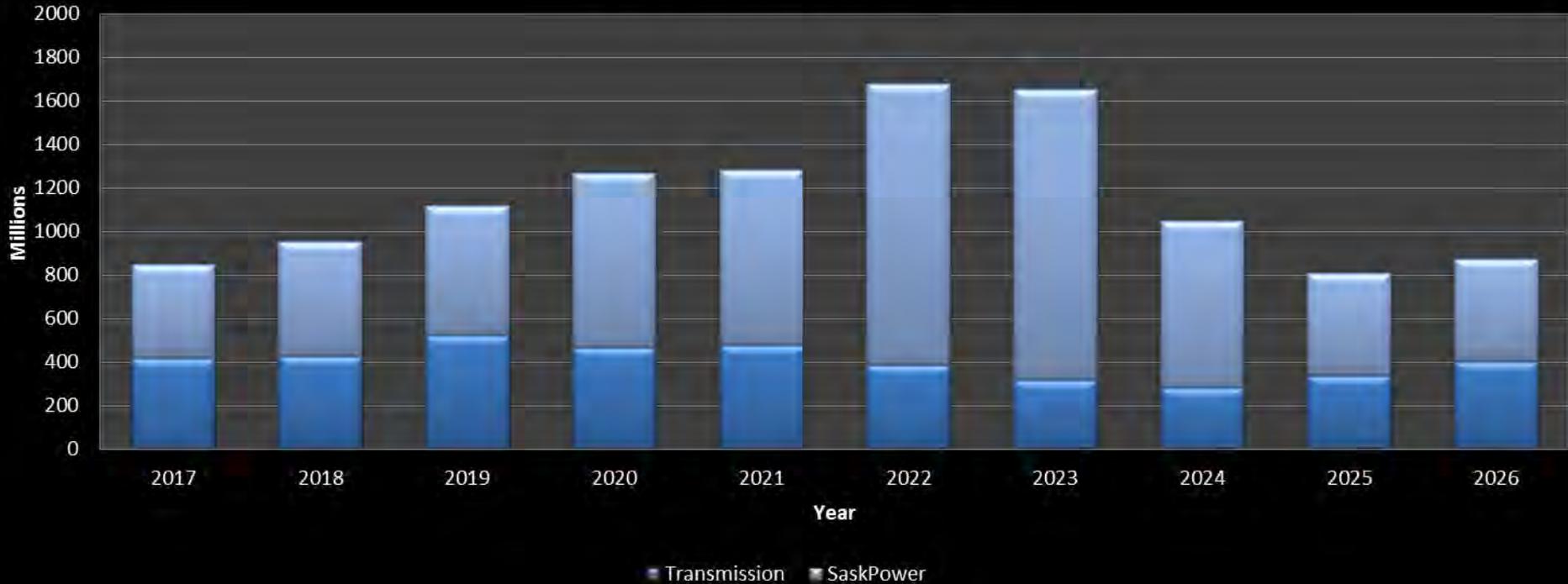
SWITCHING STATION  
 HYDRO GENERATING SITE  
 THERMAL GENERATING SITE  
 INTERNAL COMBUSTION GENERATING SITE



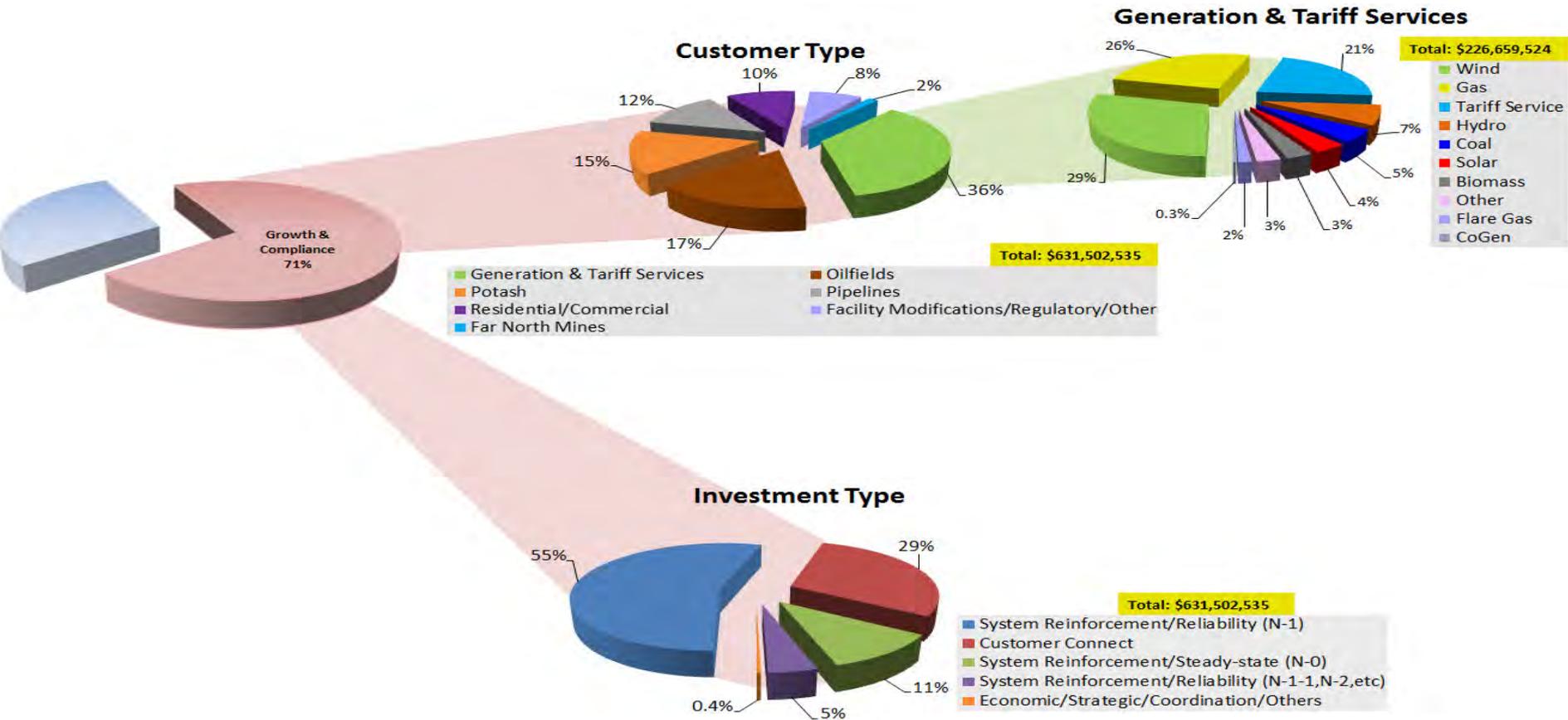
230 kV TRANSMISSION LINES  
 138 kV TRANSMISSION LINES

# Transmission

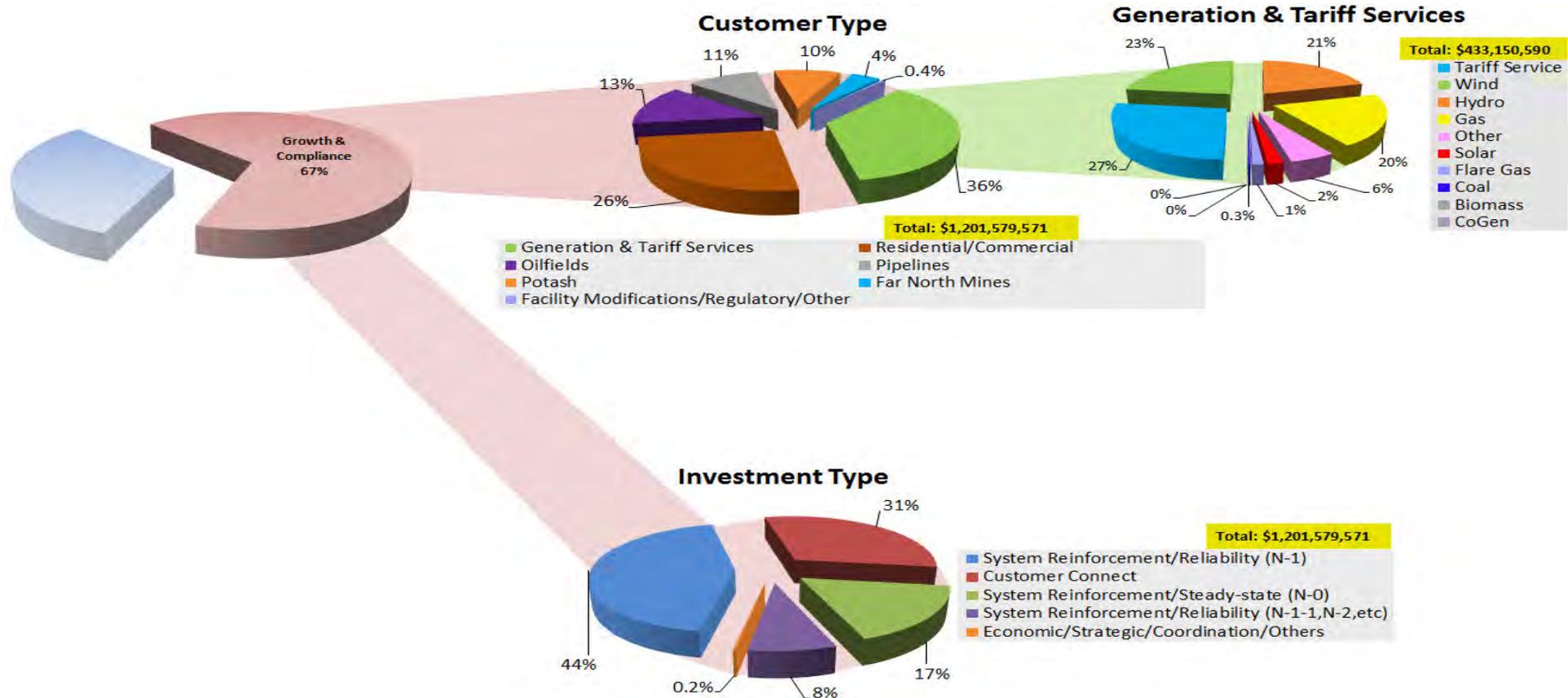
## Capital Investment



# Short Term Investment



# Medium Term Investment



# Potential Costs



# COST – COMPONENTS & DRIVERS

- **Physical interconnection cost:**
  - Cost to physically interconnect to the system
- **System upgrade cost:**
  - Cost to upgrade the system to deliver power and energy
- **Drivers for costs:**
  - Cost allocation methodology
  - Plant size, technology, controllability, location, timing, etc.
  - Type of service needed
    - Firm - ability to inject power and energy over a wide range of operating conditions
    - Non-firm - ability to inject energy only on an as-available basis

# DRIVERS FOR LOWER COSTS

- **Typical drivers for lower physical interconnection costs:**
- Project close to existing or committed transmission or distribution infrastructure (\$/km impact)
  - Buffer zone needs to be left with our facilities.
    - Proxy buffer 1 km for transmission, 0.1 km for distribution
  - Communications available in the local area (typically a \$/km impact)
  - Distribution connections - sub-station is effectively grounded on the transmission side (\$ impact)
- Local area asset condition is good (\$ impact)
- Local area has no permitting or construction issues for new facilities
  - Environmentally sensitive areas
  - Mining reservations

# TYPICAL LINE COSTS – RELATIVE

Voltage	Overhead	Underground
25 kV	\$ 70,000 / km	\$ 200,000 / km

Voltage	Overhead $\leq$ 5 km	Overhead $>$ 5 km
72 or 138 kV	\$ 525,000 / km	\$ 445,000 / km
230 kV	\$ 590,000 / km	\$ 470,000 / km

# OTHER COSTS - COMMUNICATIONS

- Communications exists at all transmission switching stations
- SaskPower has an extensive fibre network

	Underground	Terminal
Fibre (standard)	\$ 25,000 / km	\$ 80,000
Radio	Cost varies with topology. Can be cost competitive for smaller projects.	



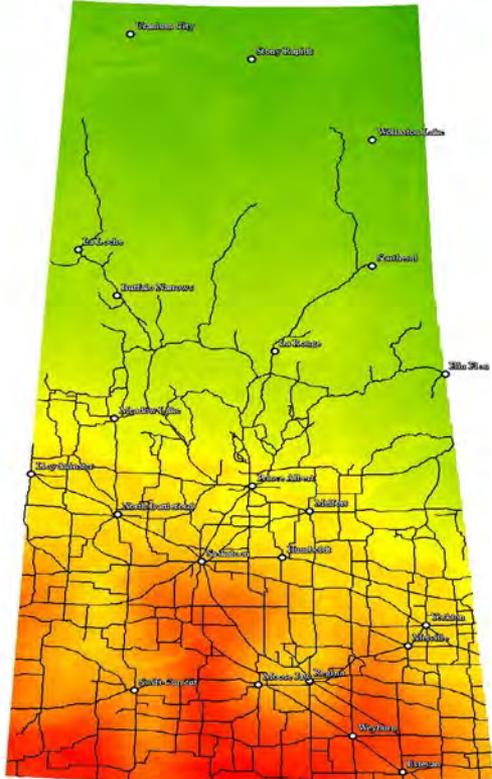
# OTHER COSTS - STATIONS

	TYPICAL COST (\$M)
NEUTRAL GROUNDING TRANSFORMER	1.5
REMEDIAL ACTION SCHEME	0.7 (depends on complexity of scheme)



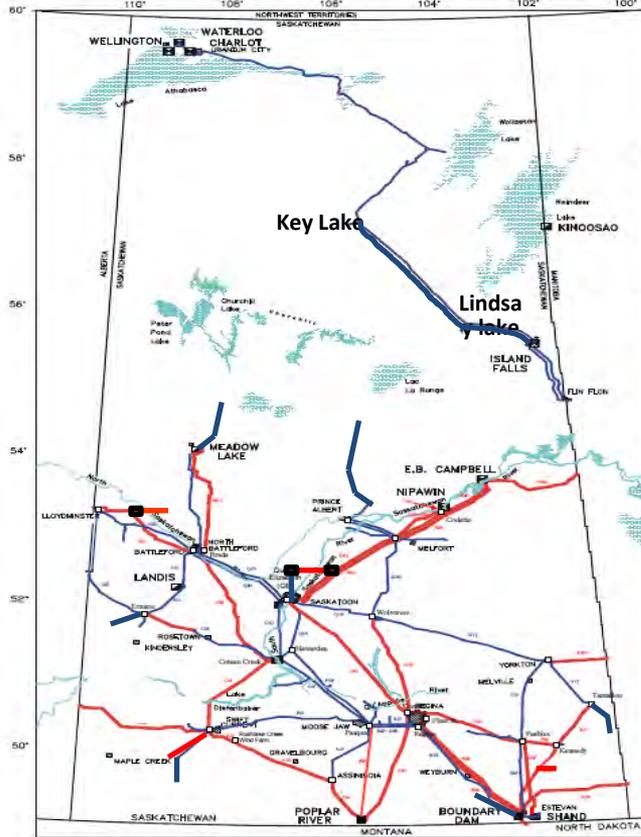
# SOLAR INTENSITY / WIND SPEED

- Highways
- GML Polygons, usage
- Watts per meter sq
- 110.0 - 114.9
- 115.0 - 119.9
- 120.0 - 124.9
- 125.0 - 129.9
- 130.0 - 134.9
- 135.0 - 139.9
- 140.0 - 144.9
- 145.0 - 149.9
- 150.0 - 154.9
- 155.0 - 159.9
- 160.0 - 164.9
- 165.0 +



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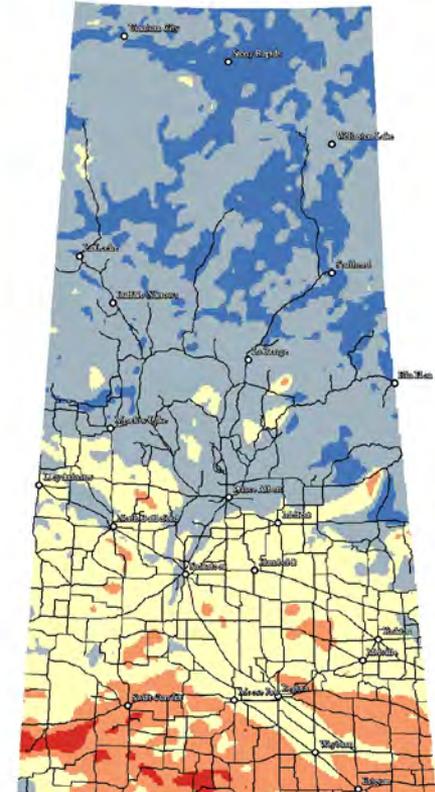
Created By: GIS Centre, June 2011



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230 kV TRANSMISSION LINES  
138 kV TRANSMISSION LINES

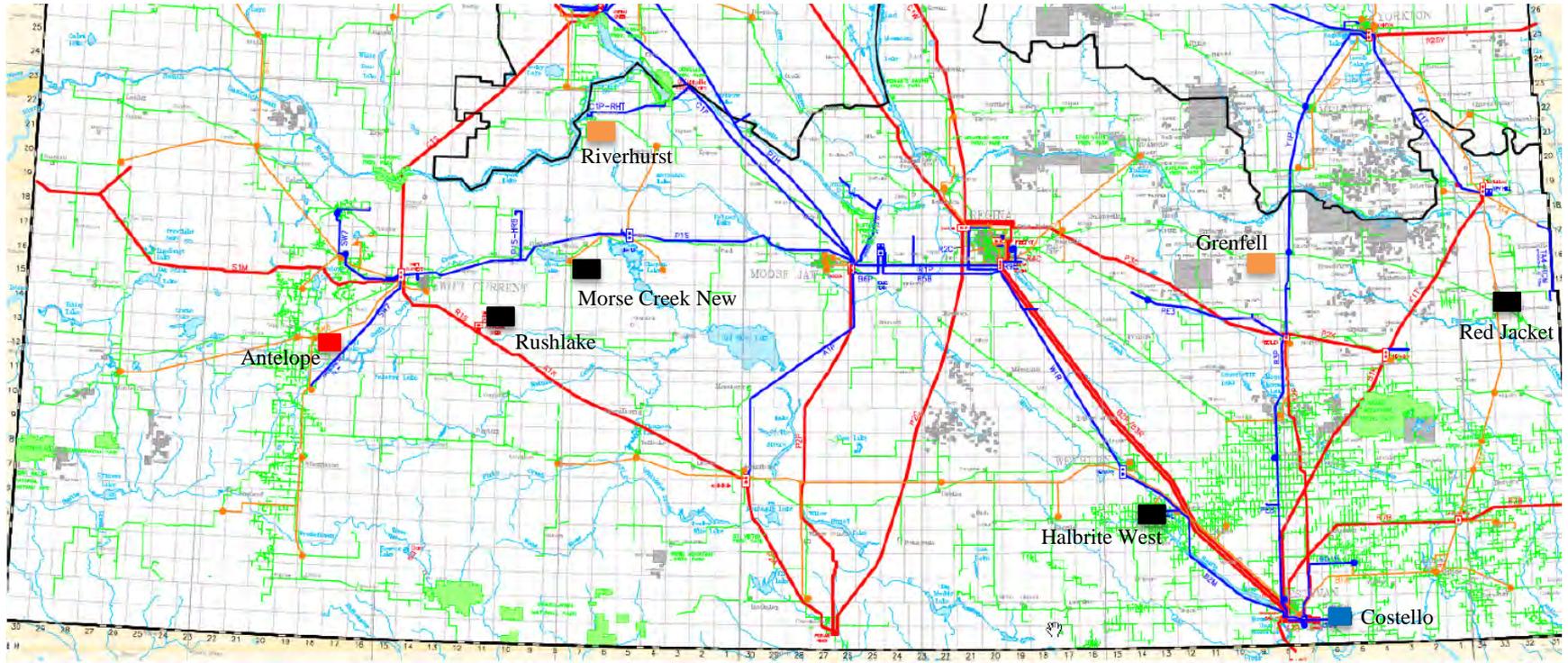
- Highways
- Meters per sec
- 4.0 - 5.4
- 5.5 - 6.2
- 6.3 - 7.0
- 7.1 - 7.7
- 7.8 - 8.5



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# POTENTIAL LOWER COST DISTR. SITES



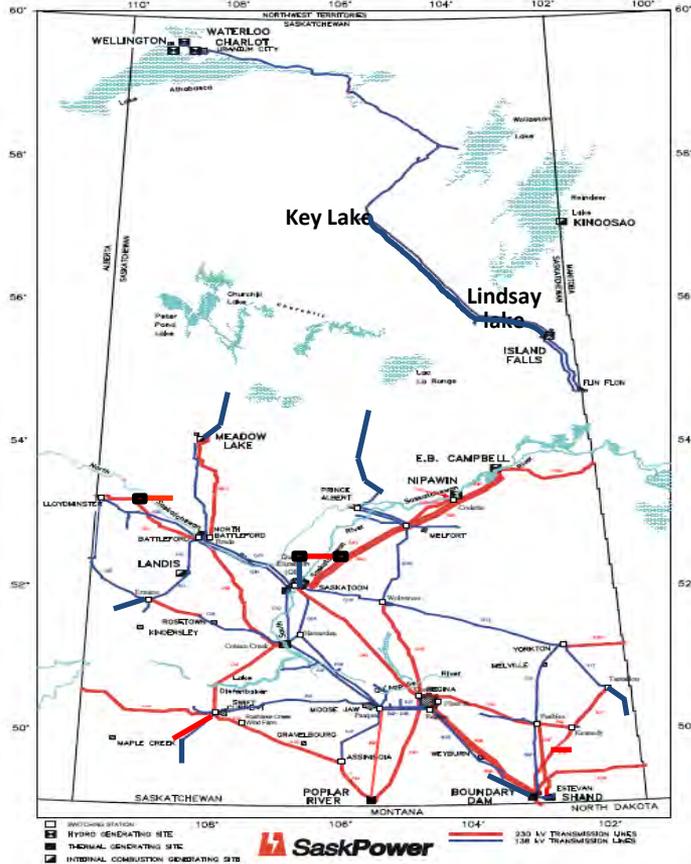
# DRIVERS FOR LOWER COSTS

- **Typical drivers for lower system upgrade costs:**
- Plant size matches capability of transmission and distribution facilities in the local or regional area
- Regional area's generation to load ratio – more load than generation
  - Close to a load centre
    - major population centres – Saskatoon , Regina
    - major industrial customers
- Low interaction with other control systems at other sites – HVDC, SVS, etc.
- System operating impacts

# CAPABILITY OF T&D FACILITIES

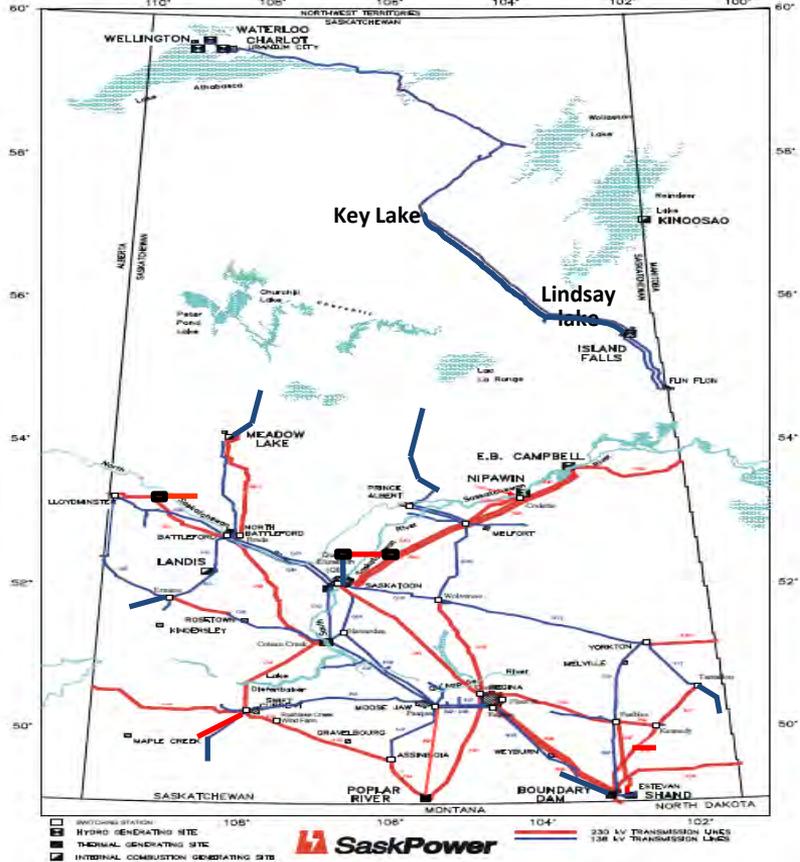


# LINES – EXISTING SYSTEM



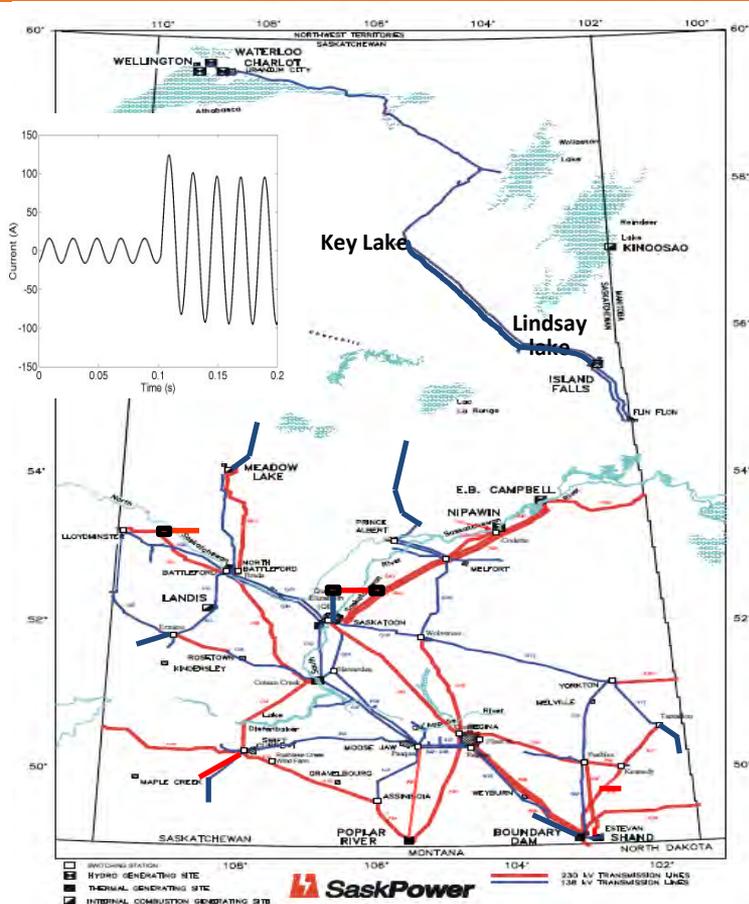
Line (kV)	Typical Physical Connectivity (MVA)
25	up to 5 to 10
72	up to 30
138	up to 100
230	100 - 350

# TRANSFORMERS – EXISTING SYSTEM



Transformer (kV)	Nameplate Range (MVA)	Typical (MVA)
72-25	2 to 20	15
138-25	15 to 50	25
230-25	50	50
138-72	30 to 120	90
230-138	150 to 350	150 or 300

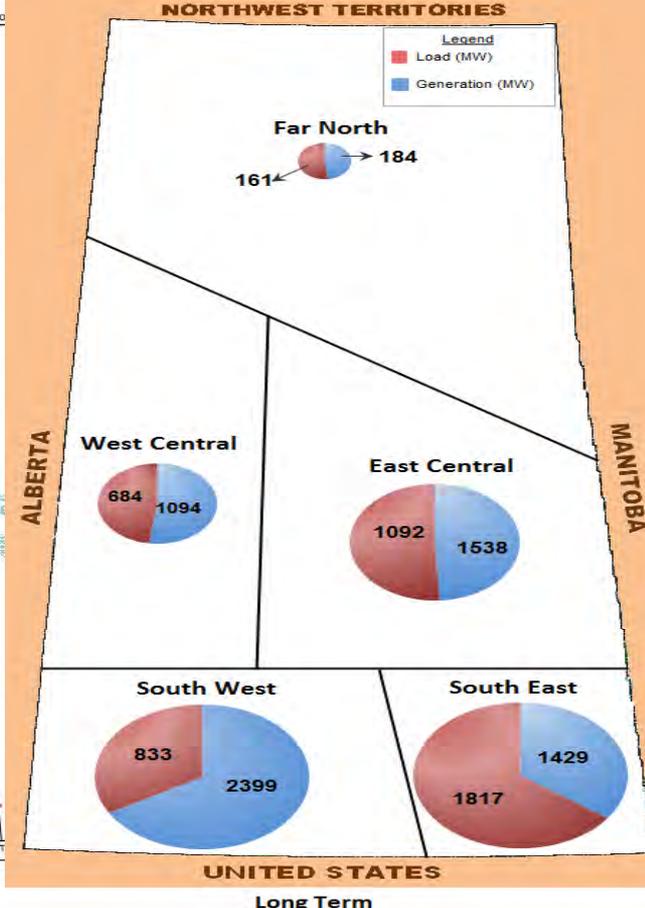
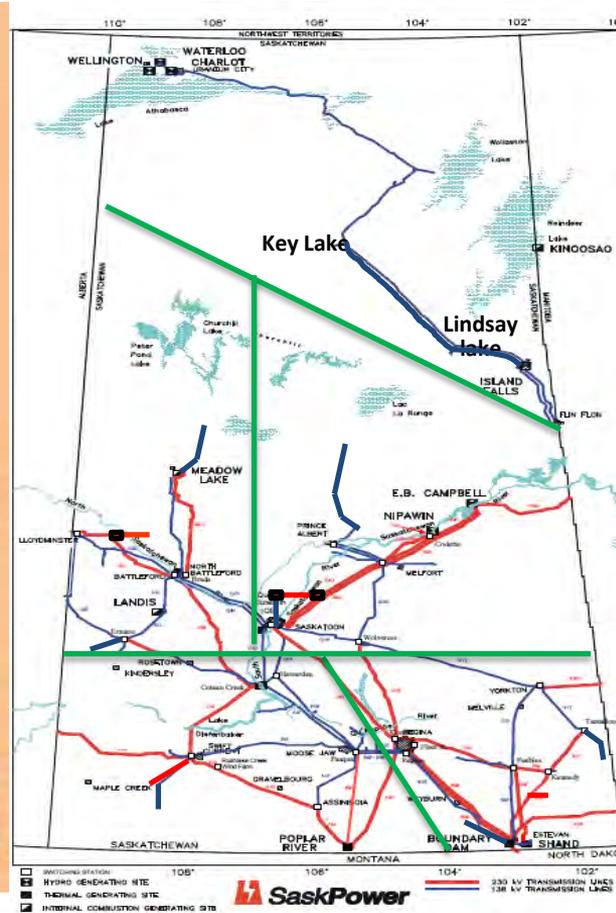
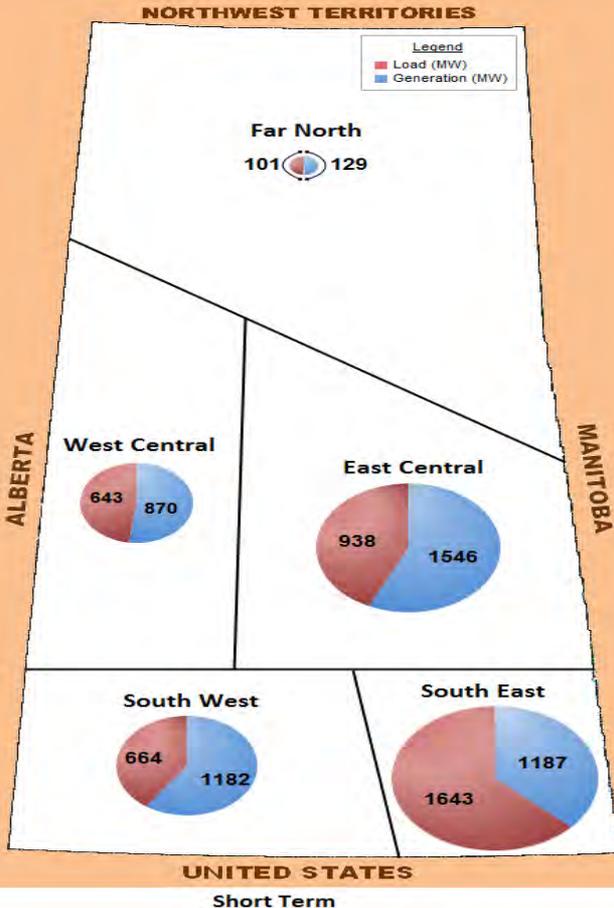
# SHORT CIRCUIT AVAILABILITY



## Existing System (System Intact)

Bus (kV)	Range (MVA)	Median (MVA)
25	18 - 507	106
72	180 - 2330	712
138	240 - 5400	1031
230	340 - 6030	1855

# REGIONAL GENERATION VS PEAK LOAD





# Illustrative Cost Examples

# 10MW PV - DISTRIBUTION

Location	Exploratory Cost Range (\$M +100%/-50%)
Typical	2.5 – 8
Halbrite	0.5 – 2
Red Jacket	4.5 – 6
Morse Creek	4.5 – 6
Antelope	4.5 – 6
Rushlake (34.5kV)	0.5 - 2

- **IPP site close to an existing sub-station.**
- Construction power costs not included.
- **Physical Interconnection**
- 1 or 10 km 25kV line (\$70k/km) – cost driver
- 1 or 10 km fibre (\$25k/km)
- Protection, automation, & control additions
- **System Upgrades**
- Addition of a new transformer at some sites – cost driver
- 10MW lower risk of additions

# 10MW PV or 25MW WIND - TRANSMISSION

- **IPP site close to 138kV radial line.**
- Construction power costs not included.
- IPP has its own 138kV switchyard.
- **Physical Interconnection**
- 1km 138kV line (\$525k/km  $\leq$  5km) – cost driver
- 1 km fibre (\$25k/km + fixed costs) – assume fibre in local area
- Protection, automation, & control additions
- **System Upgrades**
- Remedial action scheme.

Facilities	Exploratory Cost (\$M +100%/-50%)
Line – Trans.	0.525
Line – Distr.	0
Station	0
Communication	0.11
Protection, Automation, & Control	1.04
<b>Total</b>	<b>1.68</b>

# 25MW WIND - DISTRIBUTION

- IPP site close to 138kV grid line.
- Construction power costs not included.
- **Physical Interconnection**
- 1km 138kV line (\$525k/km  $\leq$  5km) – cost driver
- 1km 25kV line (\$70k/km)
- 1 km fibre (\$25k/km + fixed costs) – assume fibre in local area
- Protection, automation, & control
- **System Upgrades**
- New sub-station – cost driver
- Remedial action scheme.

Facilities	Exploratory Cost (\$M +100%/-50%)
Line – Trans.	0.525
Line – Distr.	0.070
Station	6.3
Communication	0.19
Protection, Automation, & Control	0.8
Total	7.9

# 200MW WIND - TRANSMISSION

- IPP site close to a 230kV grid line.
- Construction power costs not included.
- IPP has its own 230kV switchyard.
- **Physical Interconnection**
- 1km 230kV line (\$590k/km  $\leq$  5km) - cost driver
- 1 km fibre (\$25k/km + fixed costs) – assume fibre in local area
- Protection, automation, & control
- **System Upgrades**
- New station – cost driver
- Remedial action scheme.
- Potential for new lines – cost risk.

Facilities	Exploratory Cost (\$M +100%/-50%)
Line – Trans.	0.59
Line – Distr.	0
Station	9 (new grid station)
Communication	0.19
Protection, Automation, & Control	1.2
Total	11

# 200MW WIND - TRANSMISSION

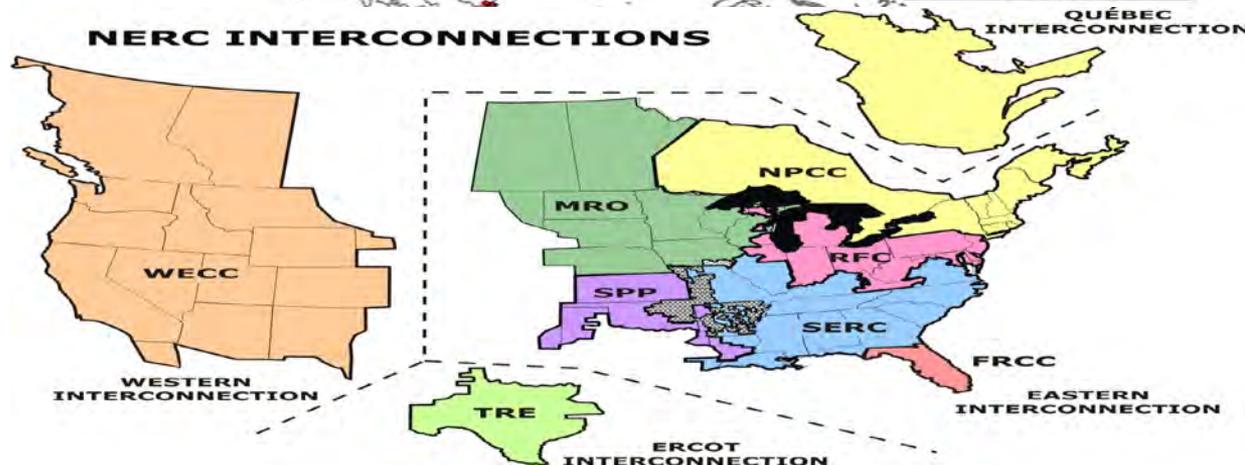
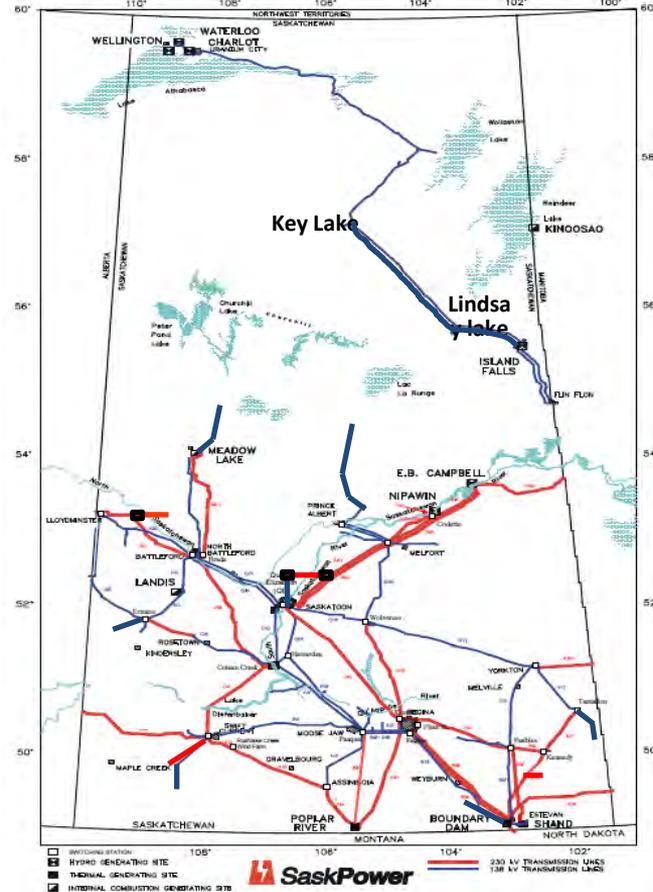
- **IPP site close to a 230kV station.**
- Construction power costs not included.
- IPP has its own 230kV switchyard.
- **Physical Interconnection**
- 1km 230kV line (\$590k/km  $\leq$  5km) - cost driver
- 1 km fibre (\$25k/km + fixed costs) – assume fibre in local area
- Protection, automation, & control
- **System Upgrades**
- Remedial action scheme.
- Potential for new lines – cost risk.

Facilities	Exploratory Cost (\$M +100%/-50%)
Line – Trans.	0.59
Line – Distr.	0
Station	3 (new breaker position)
Communication	0.19
Protection, Automation, & Control	1.2
<b>Total</b>	<b>5</b>

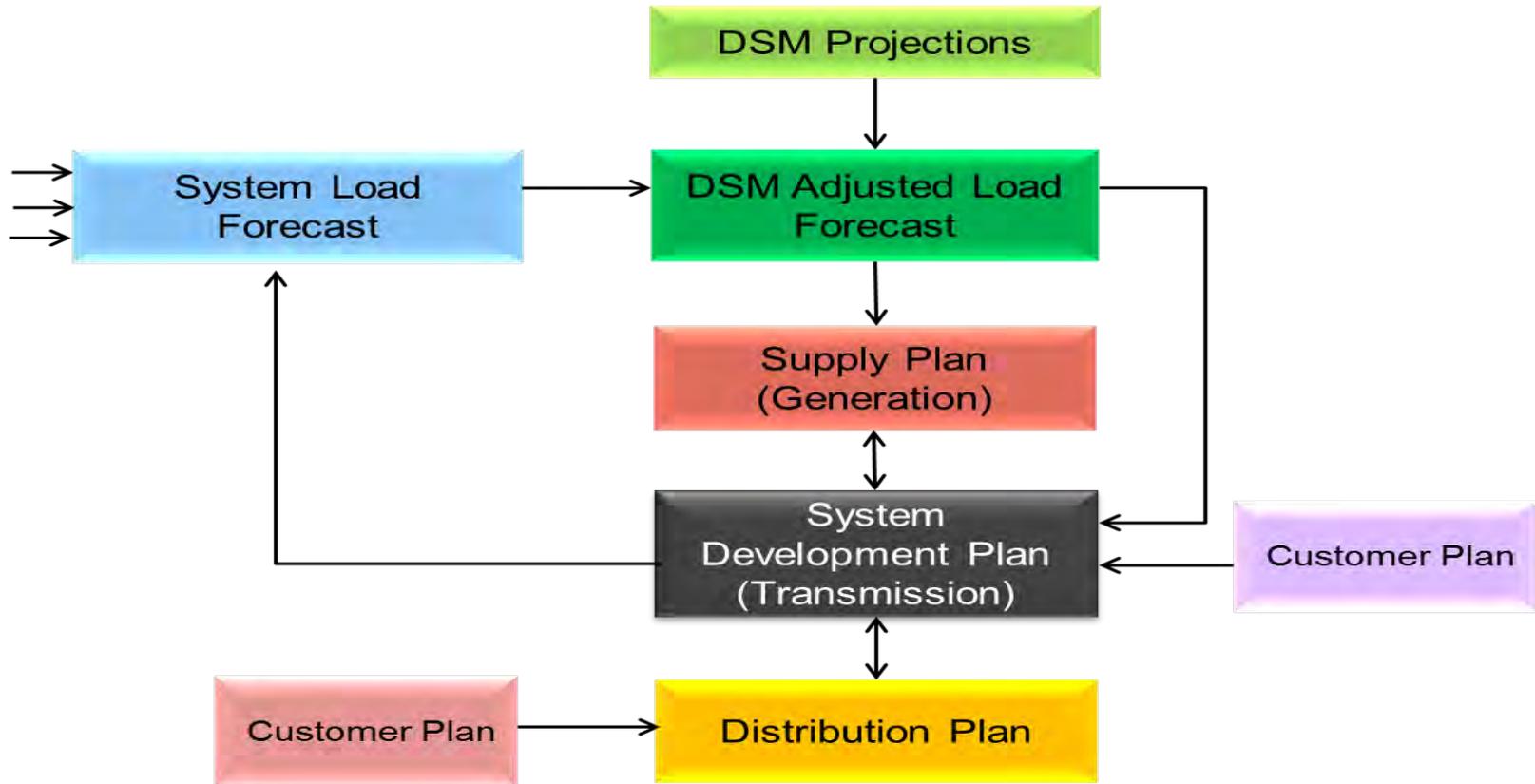
# Transmission & Interconnection Planning Process



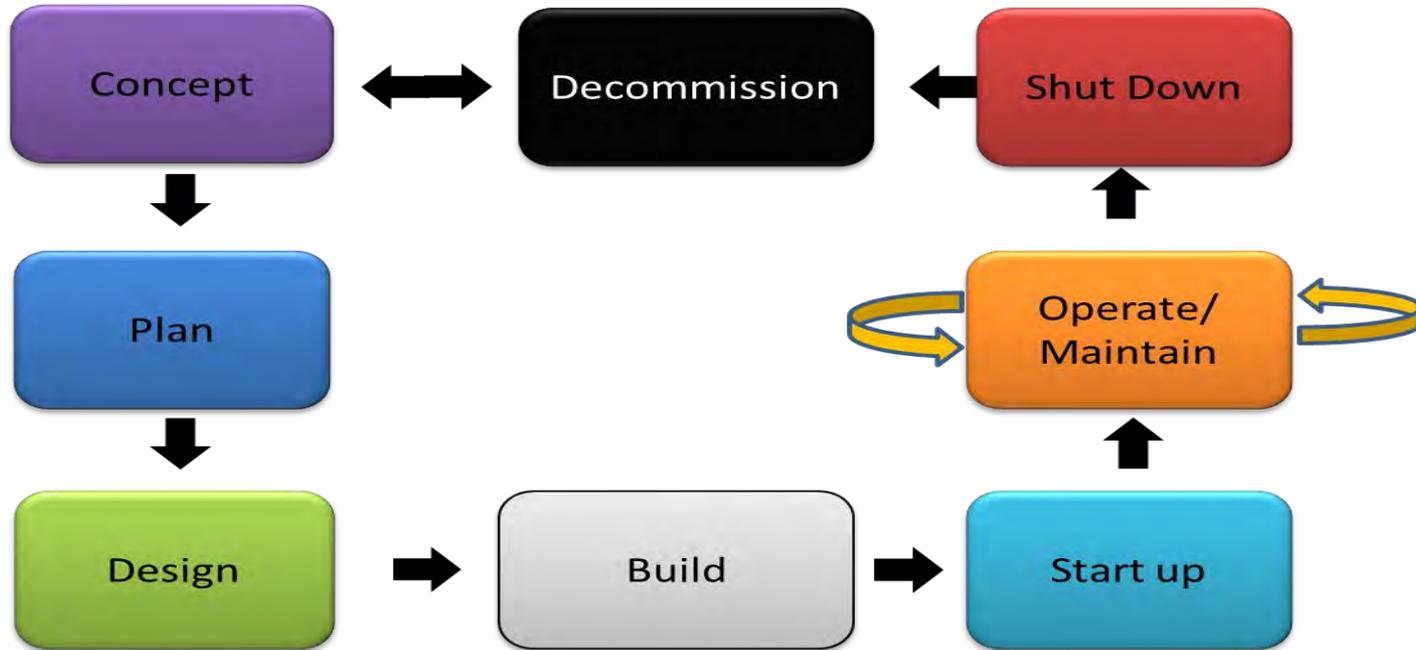
# TRANSMISSION PLANNING – WIDE VIEW



# TRANSMISSION SYSTEM PLANNING



# LIFE CYCLE PLANNING



# SYSTEM DEVELOPMENT PLAN

## Project Type

**0** Sustainment Program  
eg. Replacements

**1** Transmission Customer Connect  
Transmission Facilities Modifications  
eg: Need Customer Contract

**2** Steady State System Intact Issues  
N-0 Violation  
eg: Distribution load Increases

**3** Reliability related  
N-1 type events  
eg. Tx adequacy

**4** Reliability related  
N-1-1, N-2.. Etc  
eg: RAS for N-2 events

**5** Opportunity/Economic/Misc  
Project Coordination  
Strategic Initiatives

## Project Classification

**A** Authorized  
CPA has been issued  
Only authorized portion

**F** Firm  
Contracts in place  
Probability of proceeding: 90%+

**C** Contingent  
Agreements not in place yet  
Part of Integrated plans  
Probability of proceeding: 50%+

**P** Potential  
Possible Projects  
Long term strategic initiatives  
Low probability projects

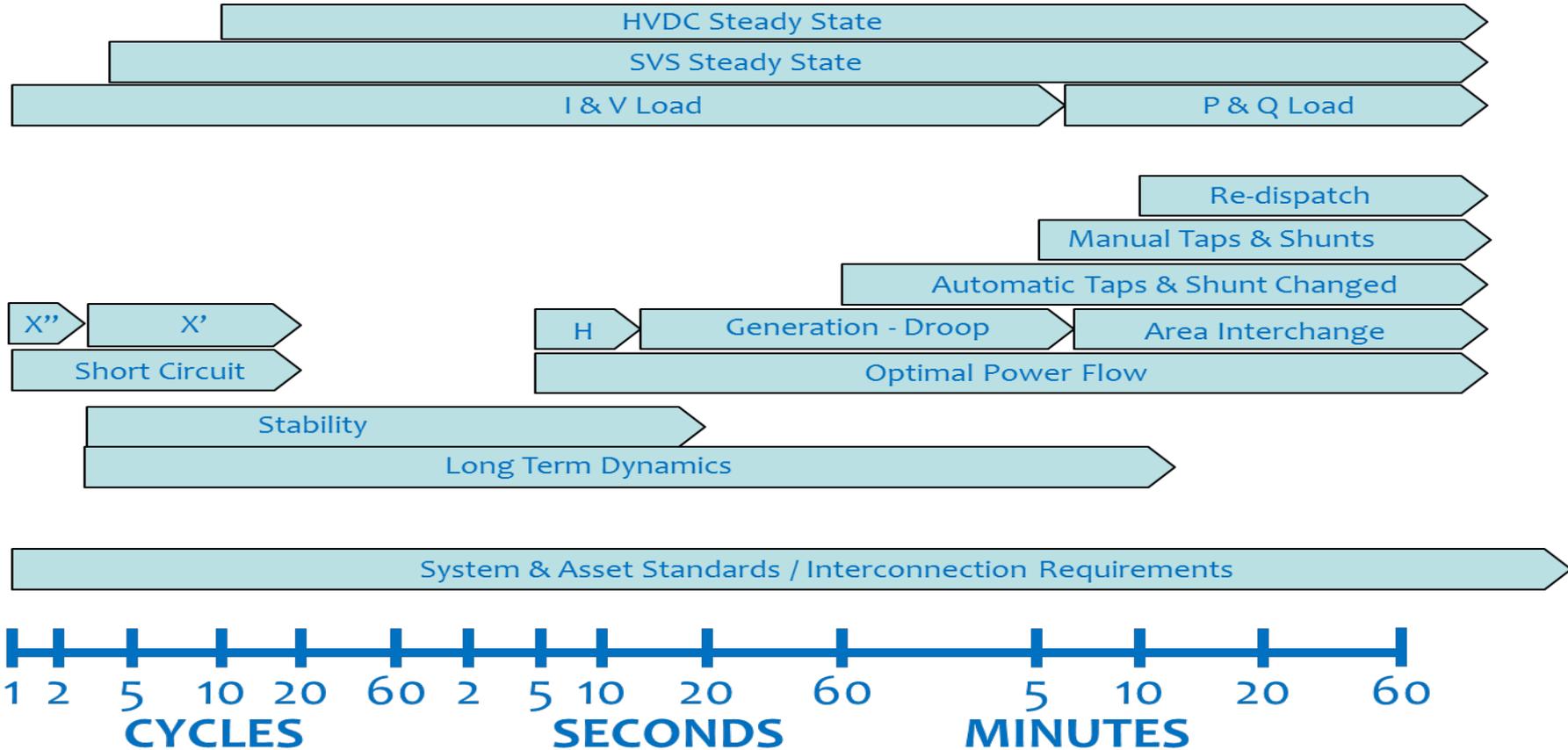
Project Type	Model Build	10 year Plan	Capital Budget
Program	Y	Y	Y
1A	Y	Y	Y
2A	Y	Y	Y
3A	Y	Y	Y
4A	Y	Y	Y
5A	Y	Y	Y
1F	Y	Y	Y
2F	Y	Y	Y
3F	Y	Y	Y
4F	Y	Y	Y
5F	Y	Y	Y
1C		Y	Y
2C		Y	Y
3C		Y	Y
4C		Y	Y
5C		Y	Y
1P			Y
2P			Y
3P			Y
4P			Y
5P			Y

# INTERCONNECTION STUDY & PROCESS

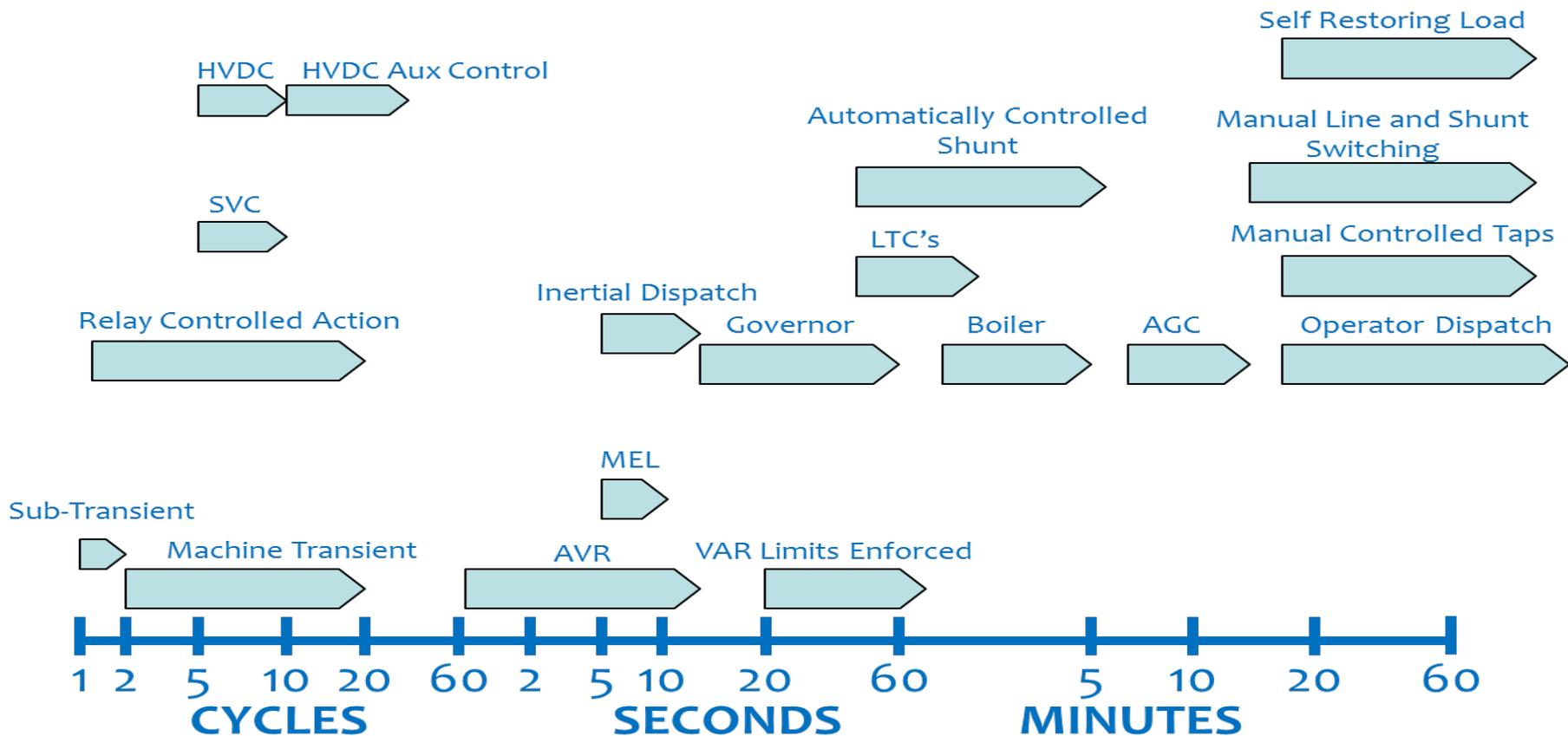


- Interconnection study - technical analysis
  - Interconnection service request - information
  - Exploratory study - conceptual planning
  - System impact study - project planning
    - Identify physical interconnection facilities
    - System impact analysis
    - Identify system upgrade facilities
    - Estimated project costs and schedule
  - Facilities study - project design & build
    - Project definition
      - Risks, costs, schedule, & delivery

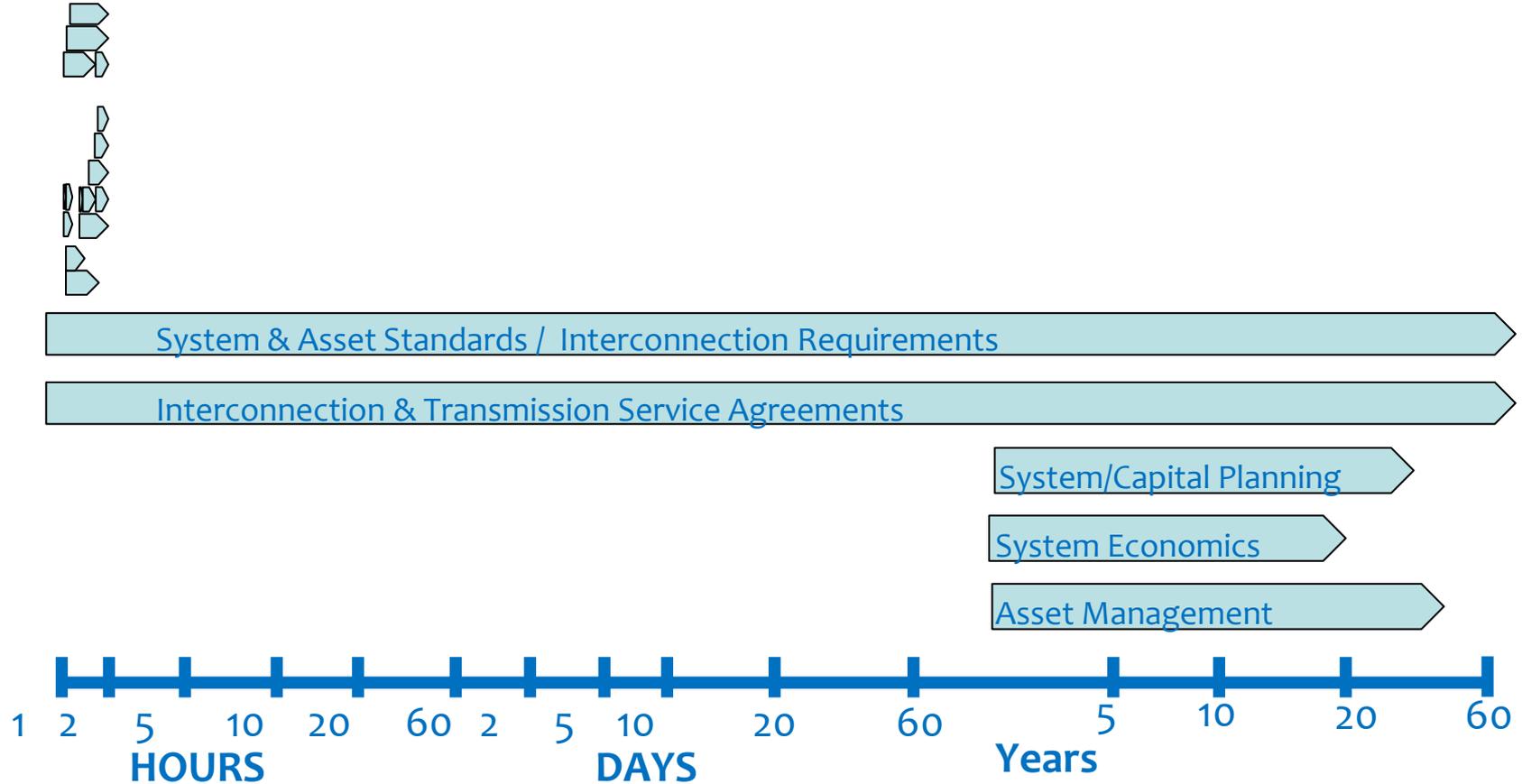
# TIME FRAME OF INTEREST



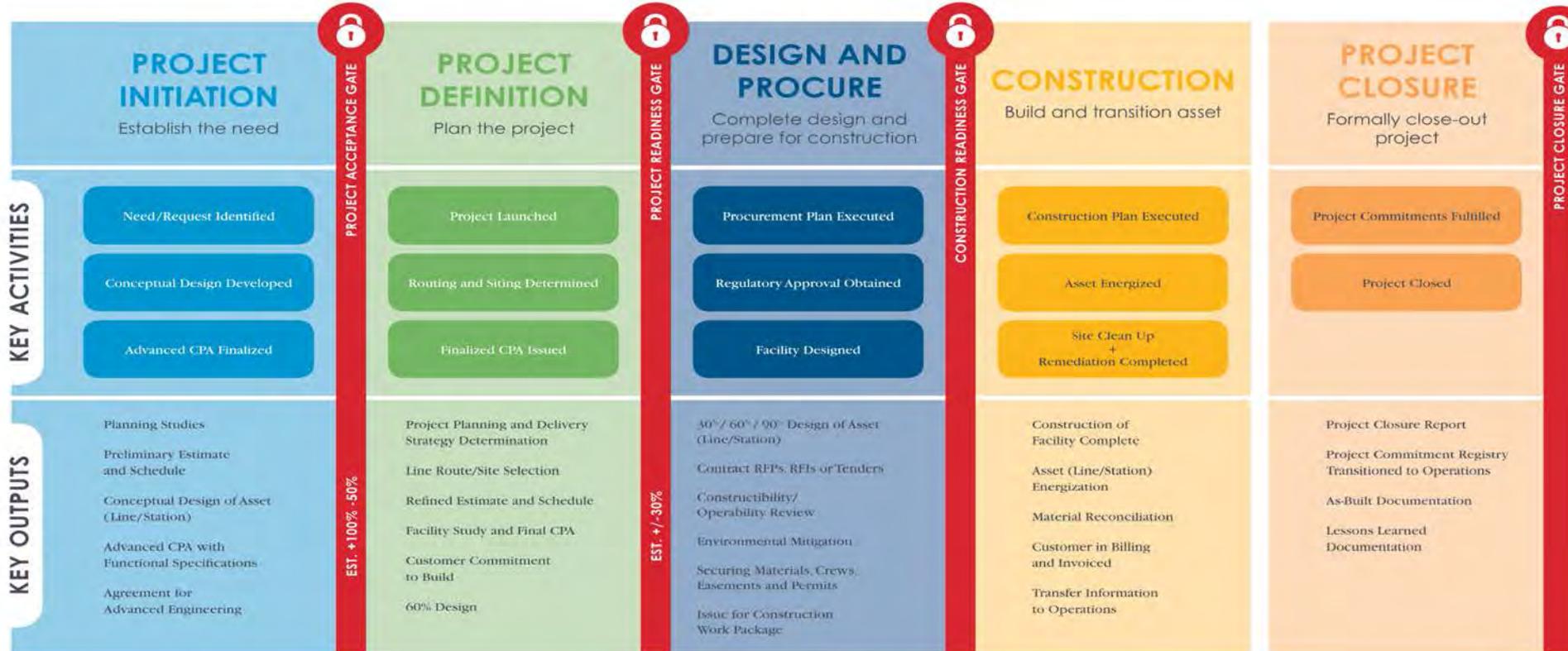
# SYSTEM INTERACTIONS



# TIME FRAME OF INTEREST



# PROJECT DELIVERY PROCESS



Thank you

